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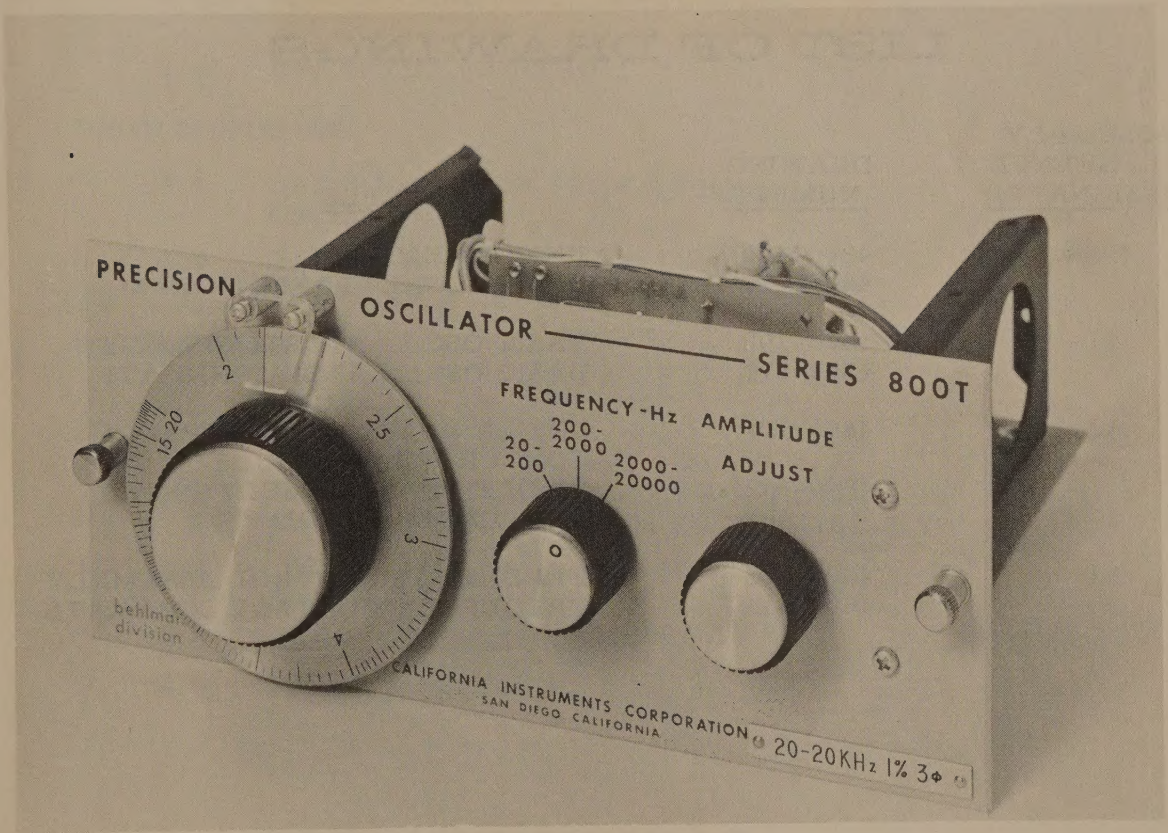
Aiken Industries
California Instruments
Division

Revision G
August, 1977

INSTRUCTION MANUAL

SERIES
800T-20/20 KHz
800T-20/20K-1-1
OSCILLATOR



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SPECIFICATIONS

	MODEL 800T-20/20K-1-1ϕ	MODEL 800T-20/20K-1-3ϕ*	MODEL 800T-20K-1-2ϕ
NUMBER OF PHASES:	Single Phase	Three Phase	Two Phase
NOMINAL PHASE SHIFT	Not Applicable	±120 degrees	+90 degrees
PHASE SEQUENCE:	Not Applicable	ABC Sequence	CA Sequence
PHASE ACCURACY AT 25°C: (with amplitude potentiometer adjusted from 75% of full output to full output)**	Not Applicable	±2 degrees maximum	±2 degrees maximum

SPECIFICATIONS COMMON TO ALL MODELS

FREQUENCY RANGE:	20 Hz to 20 KHz in three decade ranges.
FREQUENCY ACCURACY AT 25°C:	±1.0 per cent of reading.
FREQUENCY TEMPERATURE COEFFICIENT:	±0.02 per cent/°C maximum.
FREQUENCY RESPONSE:	±1.0 per cent from 20 Hz to 2.0 KHz and within ±3 per cent to 20KHz referenced to the 400Hz output.
OUTPUT AMPLITUDE:	5.000 volts rms ±50 millivolts at 400Hz for single phase model. 0 to greater than 5 volts rms for multiphase models.
AMPLITUDE STABILITY: (after one hour warm up)	±0.25 per cent for 24 hours at 25° C; ±0.02 per cent/°C maximum.

TOTAL HARMONIC DISTORTION:	0.15 per cent maximum from 45 Hz to 5 KHz and increasing to .25 per cent maximum at 20 KHz.
INPUT POWER:	±25 volts DC at approximately ±30 milliamperes available from power amplifier.
OPERATING TEMPERATURE RANGE:	0 to 55°C for all versions.
DIMENSIONS:	3 1/2" high x 8" wide x 7" deep for mounting to a California Instruments Solid State Invertron®.
FRONT PANEL FINISH:	Grey 26440, Federal Standard 595 with black silk screened lettering.

All specifications apply when tested in accordance with the test procedures given in this manual.

* Model 800T-20/20K-1-3φD will provide a three phase output when used with two power amplifiers connected in the open delta configuration.

** This is a new improved specification. Oscillators manufactured prior to October 1974 may exhibit a greater phase shift than that indicated with the AMPLITUDE potentiometer turned counter-clockwise from the full clockwise position. Step 4.6.4 was added to this manual at Revision E to test for this improved characteristic.

GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments 800T Series Variable Frequency Oscillators. A detailed theory of operation is provided as an aid to maintenance personnel. A complete parts listing, schematics and component location drawings are also supplied.

1.2 MODEL NUMBER DESCRIPTION

All oscillators in the 800T Series have a four place model number which describes the following features: the oscillator series, the output frequency range of the oscillator, the frequency tolerance of the oscillator, and the number of phases of the oscillator. In addition, a "D" is placed after the model number if the oscillator is to be used in the three phase, open delta configuration. The following examples illustrate this numbering system.

Example 1: 800T-20/20K-1-3ϕ

This is a variable frequency, three phase oscillator that covers the range from 20 Hz to 20 KHz with a specified frequency accuracy of ±1.0 per cent.

Example 2: 800T-20/20K-1-3ϕD

This is a variable frequency, three phase oscillator for use in the open delta configuration that covers the range from 20 Hz to 20 KHz with a specified frequency accuracy of ±1.0 per cent.

Example 3: 800T-20/20KHz-1-1ϕ

This is a variable frequency, single phase oscillator that covers the range from 20 Hz to 20 KHz with a specified frequency accuracy of ±1.0 per cent.

1.3 GENERAL DESCRIPTION

The California Instruments 800T Series of Variable Frequency Oscillator provide a pure sine wave output for driving the California Instruments Solid State Invertrons®. These oscillators incorporate a unique amplitude regulator circuit which prevents amplitude overshoot as the frequency of the oscillator is varied or as the decade range of the oscillator is changed. This prevents possible damage to a sensitive load connected to the output of the Invertron as a result of excessive output voltage amplitude.

The multi-phase versions of the 800T Series Oscillators are used to drive two or more Solid State Invertrons® connected so as to provide either two phase or three phase power.

1.4 ACCESSORY EQUIPMENT

The following equipment is available for use with the 800T Series Variable Frequency Oscillators.

1.4.1 4800-703 Extender Assembly. This assembly allows the oscillator to be tested and adjusted outside of the associated Solid State Invertron®.

WARNING

HIGH VOLTAGE (115 AC)

Voltages up to 500 VAC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug in oscillator, the primary power circuits, and output circuits of the associated Invertron® if oscillator is tested and adjusted with Invertron®.

INSTALLATION AND OPERATION

2.1 UNPACKING

Individual oscillators are shipped in a cardboard container with protective inner packing. Do not destroy this packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

The California Instruments 800T Series Variable Frequency Oscillators operate from plus (+) and minus (-) 25 volts DC at 0.030 amperes. This power is normally obtained from the associated Solid State Invertron®.

2.3 FUSE REQUIREMENTS

No separate fuse is required with the California Instruments 800T Series Variable Frequency Oscillators.

2.4 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. If the unit appears in good condition, perform the following:

Mount the oscillator in the appropriate California Instruments Invertron® or otherwise apply ±25 volts DC power to the unit.

2.4.1 MODEL 800T-20/20K-1-1φ SINGLE PHASE OSCILLATOR

2.4.1.1 Connect an oscilloscope, a differential voltmeter and a counter to the output of the oscillator (Pin 1 of the printed circuit connector is the output "low" and Pin 2 of the printed circuit connector is the output "high" as given in Section 2.5 of this instruction manual). Set the frequency of the 800T Series Oscillator to 400 Hz and check that the output voltage from the oscillator is 5.00 volts rms ±0.05 volts and that the output wave form is a pure sine wave with no clipping or other distortion. The counter should indicate within ±1.0 per cent of 400 Hz.

2.4.1.2 Vary the frequency of the oscillator from 20 Hz to 2.0 KHz and check that the oscillator output amplitude remains within ±1.0 per cent of its value at 400 Hz. Vary the frequency of the oscillator from 2.0 KHz to 20 KHz and check that the oscillator output amplitude remains within ±3 per cent of its value at 400 Hz. Check that the frequency of the oscillator remains within ±1 per cent of the dial setting and that the output wave form is a pure sine wave with no clipping or other distortion.

2.4.1.3 If further acceptance testing of this oscillator is required, refer to the complete test procedure given in Section 4.1 of this instruction manual.

2.4.2 MODEL 800T-20/20K-1-2ϕ TWO PHASE OSCILLATOR

2.4.2.1 Rotate the AMPLITUDE control on the two phase oscillator to a fully clockwise position and repeat steps 2.4.1.1 and 2.4.1.2 for both the "A" phase and "C" phase outputs. In this case, the output voltage should be greater than 5 volts rms and the amplitude of both phases should be within 2 per cent of each other.

2.4.2.2 Connect a differential phase meter to the "A" phase and "C" phase outputs and check that "A" phase lags "C" phase by 90° ±2° over the frequency range from 20 Hz to 20 KHz.

2.4.2.3 If further acceptance testing of this oscillator is required, refer to the complete test procedure given in Section 4.1 of this instruction manual.

2.4.3 MODEL 800T-20/20K-1-3ϕD THREE PHASE OSCILLATOR

2.4.3.1 Repeat step 2.4.2 except check that the phase "A" output lags the phase "C" output by 60° ±2°.

2.4.4 MODEL 800T-20/20K-1-3ϕ THREE PHASE OSCILLATOR

2.4.4.1 Rotate the AMPLITUDE control on the three phase oscillator to a fully clockwise position and repeat steps 2.4.1.1 and 2.4.1.2 for all three phase outputs. In this case, the output voltage should be greater than 5 volts rms and the amplitude of all three phases should be within 2 per cent of each other.

2.4.4.2 Connect a differential phase meter to the "A" phase and "C" phase outputs and check that the "A" phase output lags the "C" phase output by 120° ±2° over the frequency range from 20 Hz to 20 KHz. Connect a differential phase meter to the "A" phase and "B" phase outputs and check that the "A" phase output leads the "B" phase output by 120° ±2° over the frequency range from 20 Hz to 20 KHz.

2.4.4.3 If further acceptance testing of this oscillator is required, refer to the complete test procedure given in Section 4.1 of this instruction manual.

2.5 MECHANICAL INSTALLATION and WIRING

The 800T Series Variable Frequency Oscillators fit directly into the California Instruments Solid State Invertron® Series of power amplifiers. All power for the oscillator, as well as signal output, is coupled through the printed circuit connector at the rear of the oscillator. The following table lists the voltage and applicable connector pins.

Pin	Function	
1	Output signal low	Phase A
2	Output signal high	Phase A
3	Power ground	
4	+25 volt input	
5	-25 volt input	
6	Output signal low	Phase B
7	Output signal high	Phase B
8	Output signal low	Phase C
9	Output signal high	Phase C
10	External sync input	
C	115 volts AC line high	
D	115 volts AC line low	

The single phase version of the 800T Series Oscillator only has an "A" phase output. The two phase version and the three phase open delta version of the 800T Series Oscillator has an "A" and "C" phase output while the standard three phase version of this oscillator has all three outputs. The external sync input and 115 volt AC inputs are not used for the standard version of this oscillator.

2.6 OPERATING CONTROLS

All operating controls for the 800T-20/20K Series Oscillators are located on the front panel of the oscillator.

2.6.1 The decade range of the oscillator is determined by the three-position rotary switch identified on the front panel as FREQUENCY-Hz. The oscillator covers the range from 20 Hz to 200 Hz with this control in the counter clockwise position; 200 Hz to 2 KHz with this control in the center position; and 2 KHz to 20 KHz with this control in the clockwise position.

2.6.2 The large CALIBRATED DIAL located on the left side of the oscillator front panel is used to determine the numerical value of the frequency of the oscillator. Rotate this dial until the desired frequency is located adjacent to the hair line calibration mark just above the top of the dial.

2.6.3 Single phase versions of this oscillator have no front panel AMPLITUDE control. In this case, the GAIN control on the front panel of the Invertron® is used to control the output amplitude of the power source.

2.6.4 Multi-phase versions of this oscillator have an AMPLITUDE ADJUST control which is used to vary the output voltage level of all phases of the oscillator from 0 volts to greater than 5.0 volts rms as the control is rotated in the clockwise direction.

In a multi-phase power source, the GAIN control on each of the associated Invertrons® is used as a trim control to adjust each of the output leg voltages so that they are precisely equal to each other.

CAUTION

REMOVE POWER FROM THE SOLID STATE INVERTRON® BEFORE REMOVING OR INSERTING PLUG-IN OSCILLATOR.

CAUTION

DO NOT USE OSCILLATOR IN REGION FROM 20 Hz TO 40 Hz UNLESS OUTPUT OF INVERTRON® IS REDUCED TO AT LEAST ONE HALF VOLTAGE.

DO NOT USE OSCILLATOR IN REGION ABOVE 5 KHz UNLESS INVERTRON® IS RATED FOR OPERATION ABOVE 5 KHz.

THEORY OF OPERATION

3.1 DESCRIPTION OF SINGLE PHASE OSCILLATOR

A block diagram for the basic single phase oscillator in the 800T Series is given in Figure 2. A schematic diagram for the oscillator printed circuit board (designated as the A1 Assembly) is given in drawing D4800-071 and a schematic diagram for the frequency determining printed circuit boards (designated as the A3 Assembly) is given in drawing D4800-073. An inner connecting wiring diagram is given in drawing D4800-070 for single phase, two phase and three phase versions of this oscillator.

The frequency determining elements are arranged in a Wien bridge configuration which is connected as a positive feedback loop around an operational amplifier as illustrated in Figure 2 and fully described in Section 3.1.1 through 3.1.6 of this instruction manual. The frequency of oscillation f_o is given by the equation,

$$f_o = \frac{1}{2\pi RC}$$

where R is the total resistance in the positive feedback path and C is the total capacitance in the positive feedback path. At the frequency of oscillation f_o, the positive feedback loop has a transmission of 0.333 and a zero phase shift. The negative feedback loop must adjust the closed loop gain of the operational amplifier A1IC2 to exactly 3.00 in order for the Wien bridge oscillator to produce a pure sine wave output with a minimum of distortion. This is accomplished by means of a servo feedback loop consisting of the amplitude regulator element, a differential error integrator, a DC reference voltage and a peak detector connected as shown in Figure 2.

The output impedance of the amplitude regulator element varies as a function of its DC input voltage and, in this way, controls the closed loop gain of the operational amplifier A1IC2. The amplitude regulator is driven from the DC output of the error integrator.

The error integrator provides a DC output proportional to the difference between the value of the DC reference voltage and the output of the peak detector. The peak detector provides a DC output almost equal to the peak value of the sine wave at the output of the Wien bridge oscillator. If the sine wave output of the Wien bridge oscillator increases for any reason, then the DC output of the peak detector also increases a like amount. This, in turn, drives the output of the error integrator in a negative direction. This negative going bias at the input to the amplitude regulator causes its output impedance to increase, thereby, reducing the closed loop gain of the integrated circuit amplifier, A1IC2. This, in turn, causes the output amplitude of the Wien bridge oscillator to drop and return to its original value.

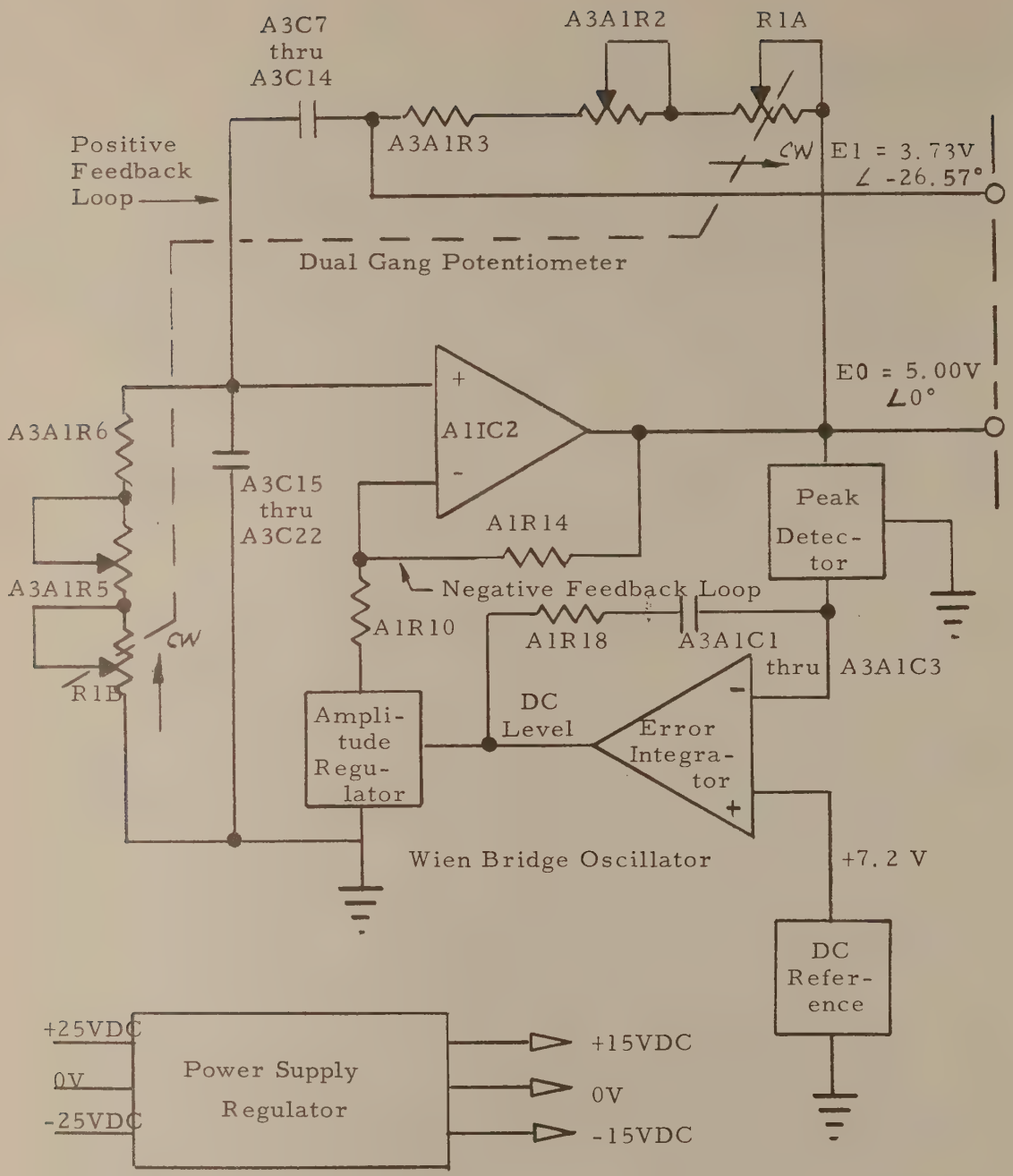


FIGURE 2. Block Diagram of Basic Wien Bridge Oscillator Employed in 800T Series Oscillator.

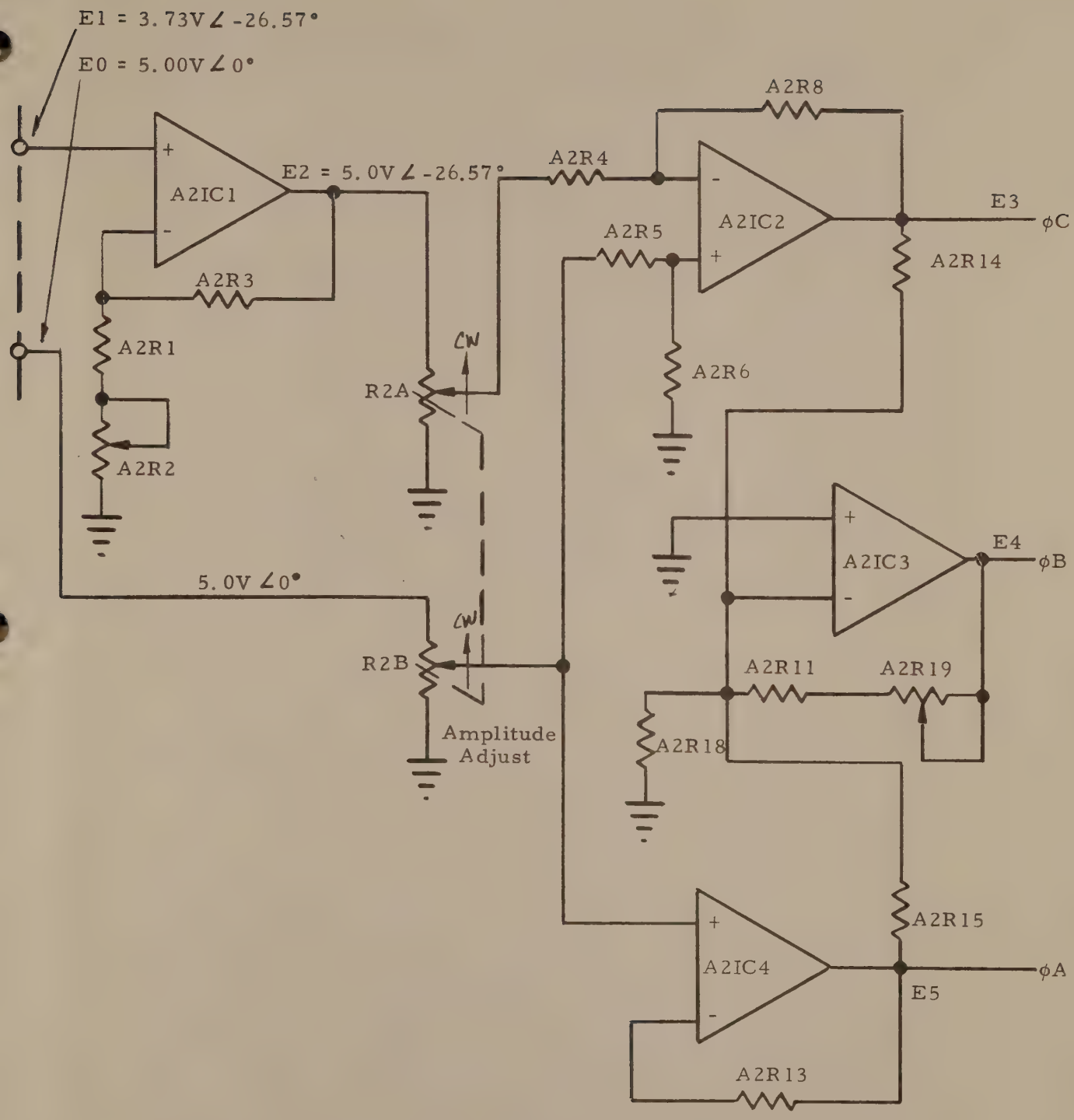


FIGURE 3. Block Diagram of Single to Multiphase Converter employed in 800T Series Oscillator.

3.1.1 RANGE SWITCH CIRCUITRY

A schematic diagram for the range switch circuitry is shown in drawing D4800-073. These circuits include the frequency determining elements of the Wien bridge oscillator as well as time constant determining elements for both the peak detector and the error integrator.

Capacitors A3C12, A3C13, A3C14, A3C20, A3C21 and A3C22 are switched into the Wien bridge oscillator on the 20 Hz to 200 Hz range. Capacitors A3C9, A3C10, A3C11, A3C17, A3C18 and A3C19 are switched into the Wien bridge oscillator on the 200 Hz to 2 KHz range. Capacitors A3C7, A3C8, A3C15 and A3C16 are switched into the oscillator circuit on 2 KHz to 20 KHz range. Capacitors A3C7, A3C10, A3C12, A3C15, A3C18 and A3C20 are used to compensate for the temperature coefficient of A3C8, A3C11, A3C13, A3C16, A3C19 and A3C21, respectively. Capacitors A3C7, A3C9, A3C14, A3C15, A3C17 and A3C22 are determined at the factory so that the low frequency limits of each range are in exact decade steps with respect to each other.

Potentiometers A3A1R1, A3A1R2, A3A1R4 and A3A1R5 are switched with the range determining switch. Their function is to set the electrical range limits of the front panel precision potentiometer R1A, R1B so that the CALIBRATED DIAL covers an exact frequency decade as it is rotated from the "2" indication to the "20" indication.

Capacitors A3A1C1, A3A1C2 and A3A1C3 are switched with the range determining capacitors. Their function is to determine the time constant of the error integrator.

Capacitor A3A1C4, A3A1C5 and A1A3C6 are also switched with the range determining capacitors. The function of these capacitors is to determine the time constant of the filter associated with the peak detector.

3.1.2 AMPLITUDE REGULATOR ELEMENT

The amplitude regulator element consists of mosfet A1Q3 and associated components given in drawing D4800-071. The output impedance of the mosfet varies from approximately 125 ohms with +10 volts gate bias to 250 ohms with 0 volts gate bias and to 100 megohms with -4 volts gate bias. Under normal operating conditions, the gate bias on A1Q3 is between +10 and +2 volts DC which provides a mosfet output impedance between 125 ohms and 200 ohms. Potentiometer A1R11, which is in series with the output of the amplitude regulator, is adjusted to a region which provides both reliable starting of the oscillator over the full 20 Hz to 20 KHz frequency range and an output distortion of less than 0.15 per cent over the frequency range from 45 Hz to 5 KHz, when measured at eyelet A1-14.

3.1.3 DIFFERENTIAL ERROR INTEGRATOR

The differential error integrator consists of integrated circuit A1IC3 and associated components connected as shown in drawing D4800-071. Capacitors A1C3, A1C4 and resistor A1R15 form a pair of local feedback loops which are used to provide an adequate high frequency stability margin when A1IC3 is used as an operational integrator. The integrating capacitor is selected from A3A1C1, A3A1C2 and A3A1C3 as determined by the range selector switch A3S1. The DC reference voltage is applied to the non-inverting input of the error integrator and the output of the peak detector is applied to the inverting input of the error integrator. Therefore, when the peak detector output voltage exceeds the DC reference voltage, the output of the error integrator will be driven in the negative direction.

3.1.4 PEAK DETECTOR

The peak detector consists of diode A1CR7 and a filter capacitor selected by range switch A3S1. The DC output voltage of the peak detector is approximately 200 millivolts below the peak value of the sine wave output from the Wien bridge oscillator. This corresponds to a peak current of approximately 200 micro amperes through the detector diode.

3.1.5 DC REFERENCE

The DC reference consists of transistor A1Q1, zener diode A1CR1, integrated circuit A1IC1 and associated components as given in drawing D4800-071. Transistor A1Q1 is connected as a constant current source and provides power to the zener reference diode A1CR1. The +6.2 volt DC output of this diode is amplified to approximately 7.2 volts by A1IC1 connected as a voltage amplifier. Resistor A1R1 is selected at the factory so that the output of the single phase oscillator is 5.00 volts rms ±0.05 volts.

3.1.6 REGULATED DC POWER SUPPLIES

The DC regulated power supply consists of transistors A1Q2, A2Q4 and associated components as also given in drawing D4800-071. Transistor A1Q2 is connected in the emitter follower configuration and supplies +15 volts ±1.5 volt. The ripple on this regulated power supply is less than 20 millivolts peak-to-peak. Transistor A1Q4 is also connected in the emitter follower configuration and supplies -15 volts ±1.5 volt with less than 20 millivolts peak-to-peak ripple.

3.2 GENERAL DESCRIPTION OF SINGLE PHASE TO MULTI-PHASE CONVERTER

A block diagram for the single phase to multi-phase converter is given in Figure 3. This circuit employs an analog computer technique of generating the second and third phases of the multi-phase output. This technique requires no additional tuned circuits and provides the required phase shift independent of oscillator frequency.

The operation of this circuit is dependent on the signal E1 which is available at the junction of the resistive and capacitive elements in the positive feedback loop of the Wien bridge oscillator. A detailed analysis of the basic Wien bridge circuit configuration reveals that the voltage E1 at the frequency of the oscillation fo given by:

$$E1 = 0.745\, E0 \angle -26.57°$$

Therefore, as the frequency of the Wien bridge oscillator changes, with changes in R1A and R1B, the voltage E1 remains fixed in amplitude and phase shift with respect to the basic oscillator output voltage, E0.

The voltages, E0 and E1, are then processed through a sequence of operational amplifiers to provide the phase "A", phase "B" and phase "C" outputs. The vector diagram below describes how this is accomplished in graphical terms with the AMPLITUDE potentiometer R2 in the fully clockwise position.

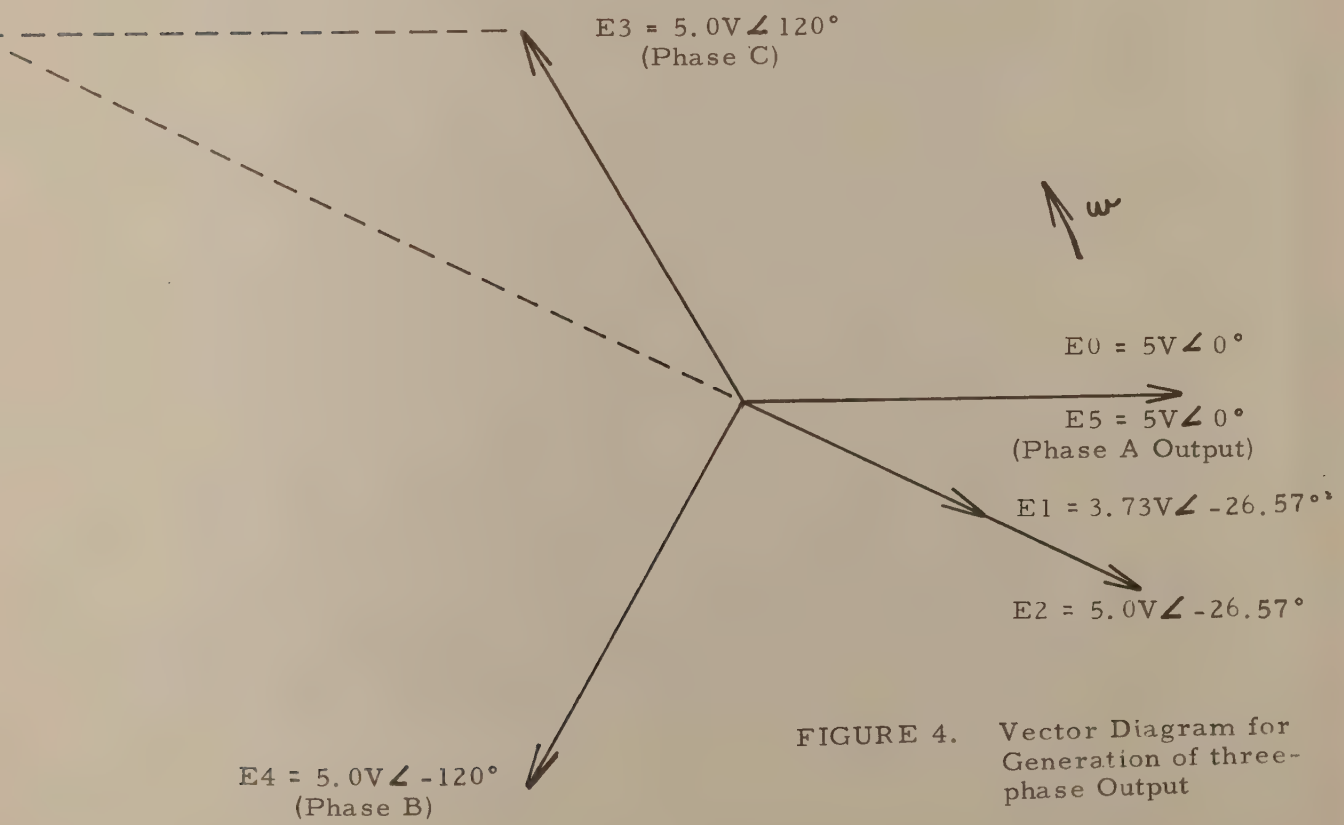


FIGURE 4. Vector Diagram for Generation of three-phase Output

First E1 is amplified by a factor of 1.34 to generate E2 at the output of A2IC1. Then E2 is inverted and amplified by a factor of -1.94 by means of the inverting input to A2IC2. The output of the Wien bridge is amplified by a factor of 1.23 with the non-inverting input to A2IC2. The resultant output from A2IC2 provides an E3 (or phase "C") output.

Then E0 is processed through a voltage follower to provide an E5 (or phase "A") output at the output of A2IC4.

Finally, E3 and E5 are added algebraically and then inverted to provide an E4 (or phase "B") output at the output of A2IC3.

For two phase operation, the gain of A2IC2, referenced to the E2 and E0 signals, is changed to -2.245 and 2.01 respectively. This provides a 90 degree phase lead for the phase "C" signal when referenced to the phase "A" signal. The phase "B" signal is not used in this application of the oscillator. For three phase open delta operation, the gain of A2IC2, referenced to the E2 and E0 signals, is changed to -1.94 and 2.24 respectively. This provides a 60 degree phase lead for the phase "C" signal when referenced to the phase "A" signal. The phase "B" signal is not used in this application of the oscillator.

WARNING

HIGH VOLTAGE (115 AC)

Voltages up to 500 VAC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug in oscillator, the primary power circuits, and output circuits of the associated Invertron if oscillator is tested and adjusted with Invertron®.

TEST PROCEDURE

4.1 GENERAL

The following test procedure may be performed on a routine basis to insure that the 800T-20/20 KHz Variable Frequency Oscillator remains within the specified performance limits. This test procedure is divided into several sections. These are:

1) Accuracy of the frequency dial calibration and frequency stability
2) Output voltage and amplitude stability
3) Harmonic distortion
4) Phase accuracy

4.2 TEST EQUIPMENT

The following test equipment is required to perform the test procedure:

a) Oscilloscope, Tektronix 531A with general purpose plug-in or equivalent
b) California Instruments Power Source or two H.P. 721A DC Power Supplies or equivalent
c) Distortion Analyzer, H.P. H02-330B or equivalent
d) Differential Voltmeter, Fluke 883A or equivalent
e) Frequency Meter, H.P. 523 CR or equivalent
f) Phase Meter, Dranetz Model 301 or equivalent

4.3 ACCURACY OF THE FREQUENCY DIAL CALIBRATION and FREQUENCY STABILITY

4.3.1 Connect the variable frequency oscillator as shown in Figure 5 and allow the unit to warm up for one hour in a 25°C environment. The output voltage should be approximately 5 volts rms. Adjust the AMPLITUDE control on the multiphase oscillators, as required.

4.3.2 Measure and record the phase "A" output frequency and the CALIBRATED DIAL setting over the range from 20 Hz to 20 KHz. The measured frequency should agree with the CALIBRATED DIAL setting within ±1.0 per cent. Refer to the CALIBRATION PROCEDURE given in Section 5.3 through 5.7 of this manual if problems are encountered.

4.3.3 Adjust the frequency of the oscillator to exactly 400 Hz with the CALIBRATED DIAL in a 25°C environment. Increase the ambient temperature to 50°C and allow the

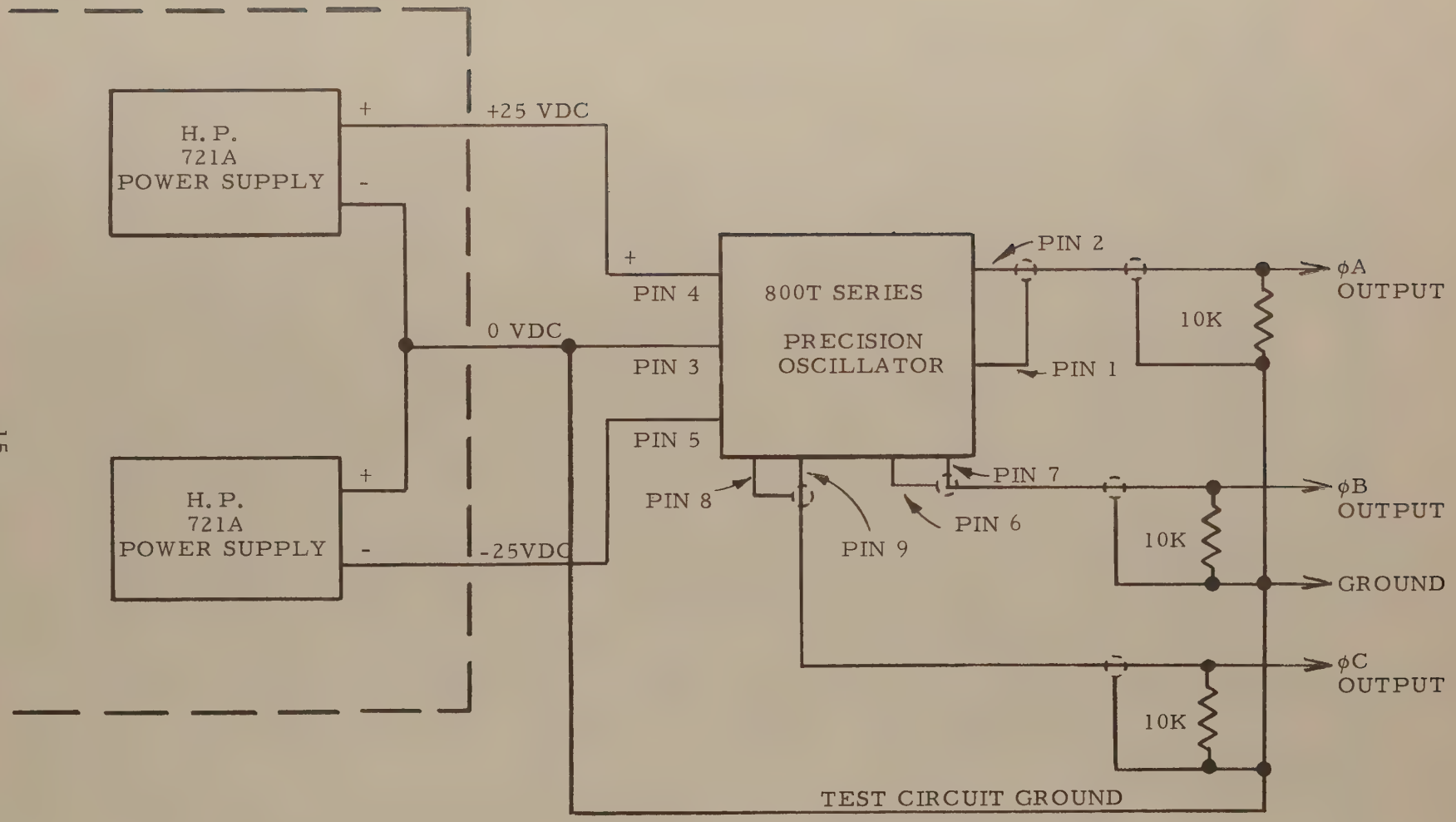


FIGURE 5. Test Circuit for 800T Series Variable Frequency Oscillators

oscillator to stabilize for one hour. The output frequency should change less than ±0.5 per cent from that indicated at 25°C.

4.3.4 Step 4.3.3 may be repeated at other oscillator frequencies as required.

4.4 OUTPUT VOLTAGE AND AMPLITUDE STABILITY

4.4.1 Connect the variable frequency oscillator as shown in Figure 5 and allow the unit to warm up for one hour in a 25°C environment. Set the frequency of the oscillator to 400 Hz. In the case of a multiphase oscillator, rotate the AMPLITUDE control fully clockwise.

4.4.2 The output of the oscillator should be measured with differential voltmeter connected to the phase "A" output (Pin 1 and Pin 2 of the printed circuit connector). The output voltage should be 5.0 volts rms ±0.05 volt rms for single phase versions of this oscillator and greater than 5.0 volts rms for multiphase versions of this oscillator. Record the exact value of the output voltage.

4.4.3 Measure the phase "A" output voltage in 15 minute increments for two hours. The change in output voltage must not exceed ±12.5 millivolts rms. This test may be continued for 24 hours if required. Maintain the ambient temperature at 25°C for this test.

4.4.4 Increase the ambient temperature to 50°C and allow the unit to stabilize for one hour. The output should change less than ±25 millivolts rms.

4.4.5 Steps 4.4.3 and 4.4.4 may be repeated for other frequencies in the 20 Hz to 20 KHz range, if desired.

4.4.6 Vary the oscillator frequency from 20 Hz to 20 KHz and check that the output amplitude remains within a ±1 per cent band from 20 Hz to 2.0 KHz and within a ±3 per cent band from 20 Hz to 20 KHz referenced to the output at 400 Hz. If problems are encountered, refer to Section 5.8 of this instruction manual.

4.4.7 For multiphase versions of this oscillator, repeat step 4.4.6 for both the phase "B" and phase "C" outputs. If problems are encountered, refer to Section 5.10 through 5.12 of this instruction manual.

4.4.8 For multiphase versions of this oscillator, all output voltages must have the same amplitude within 2 per cent over the 20 Hz to 20 KHz frequency range.

4.5 HARMONIC DISTORTION

4.5.1 Connect the variable frequency oscillator as shown in Figure 5 and allow the unit to warm up for a few minutes. In the case of multiphase oscillators, turn the AMPLITUDE control fully clockwise.

4.5.2 Connect the distortion analyzer between the high output of phase "A" and the ground. The distortion should be less than 0.15 per cent over the frequency range from 45 Hz to 5 KHz and less than 0.25 per cent from 5 KHz to 20 KHz. If problems are encountered, refer to Section 5.9 of this instruction manual.

4.5.3 If the oscillator is a multiphase oscillator, then repeat 4.5.2 for the other phase or phases. The distortion should not exceed that specified in Section 4.5.2.

4.6 PHASE ACCURACY

This section of the manual is only applicable to the multiphase oscillators. Connect the oscillator as shown in Figure 5 and allow the unit to warm up for one hour in a 25°C environment.

4.6.1 Rotate the front panel AMPLITUDE control fully clockwise so that the output of phase "A" (Pin 1 and Pin 2 of the printed circuit connector) is greater than 5 volts rms. Set the oscillator frequency to 400 Hz.

4.6.2 Connect a differential phase meter between the phase "A" output and the phase "C" output so that the phase meter reads the phase "C" output referenced to the phase "A" output. The phase meter should indicate +60 ±2 degrees for the three phase open delta oscillator; +90 ±2 degrees for the two phase oscillator; and +120 ±2 degrees for the standard three phase oscillator. Repeat this test over the 20 Hz to 20 KHz frequency range.

4.6.3 For the standard three phase oscillator, measure the phase shift of the phase "B" output referenced to the phase "A" output. This phase shift must be -120 ±2 degrees over the 20 Hz to 20 KHz frequency range. If problems are encountered, refer to Section 5.10 through 5.12 of this instruction manual.

4.6.4 Section 4.6.4 applies only to oscillators manufactured after October 1974. See page ii for further information. Set the oscillator frequency to 400 Hz and vary the front panel AMPLITUDE potentiometer from 75 per cent of full output to full output and check that all phases track within 100 millivolts rms of each other and that the phase angles remain within the ±2 degree tolerance. Repeat for other frequencies over the 20 Hz to 20 KHz range, as desired. The amplitude and phase tracking should remain within the above tolerances.

CALIBRATION PROCEDURE

5.1 GENERAL

The following calibration procedure should be followed during initial check out of the oscillator or after any service to the frequency determining circuitry. See Figure 6 for location of internal adjustments.

The calibration procedure is divided into several sections and should be performed in this sequence. The sections are:

1) Mechanical adjustment procedure for calibrated frequency dial

2) Initial calibration procedure for Wien bridge oscillator

3) Exact frequency calibration procedure for Wien bridge oscillator on 20 Hz to 200 Hz range

4) Exact frequency calibration procedure for Wien bridge oscillator on 200 Hz to 2 KHz range

5) Exact frequency calibration procedure for Wien bridge oscillator on 2 KHz to 20 KHz range

6) Frequency response adjustments

7) Absolute AC output voltage and harmonic distortion

8) Phase adjustments for single phase to multiphase converter.

5.2 TEST EQUIPMENT REQUIRED

The same test equipment is required for the calibration procedure as was required for the test procedure in Section 4.2 of this instruction manual.

5.3 MECHANICAL ADJUSTMENT PROCEDURE FOR CALIBRATED FREQUENCY DIAL

5.3.1 Rotate the precision potentiometer fully clockwise and then fully counter clockwise, checking that the limit of mechanical rotation agrees with or slightly exceeds the "2" indication and "20" indication on the calibrated dial. The dial stops may be adjusted by a slight amount of filing if required. If an extremely minor mechanical re-alignment is required, it may be possible to readjust the hair line slightly.

5.3.2 Check that the open resistance point on the precision potentiometer R1 is located off the calibrated section of the dial. Check that the resistance of both sections of the precision potentiometer is 500 ohms ±5 ohms in the fully counter clockwise position and 9700 ohms ±100 ohms in the fully clockwise position when measured between Pin 1 and Pin 2 of both sections of potentiometer R1. The brass coupling may be loosened and the precision potentiometer adjusted slightly, if required.

5.4 INITIAL CALIBRATION PROCEDURE FOR WIEN BRIDGE OSCILLATOR

5.4.1 Connect the variable frequency oscillator as shown in Figure 5 using either the ±25 volt power supply in the California Instruments Invertron® or a pair of external +25 volt and -25 volt DC power supplies. Each power supply should draw from 15 to 30 milliamperes. Allow the unit to warm up for one half hour. Check that the procedure given in 5.3.1 and 5.3.2 has been performed before proceeding further.

5.4.2 Adjust potentiometers A3A1R1, A3A1R2, A3A1R4 and A3A1R5 so that the arm of each potentiometer measures 120 ohms ±1.0 ohm to the open end of the potentiometer. This is best accomplished by connecting an ohmmeter from the arm of the potentiometer to the open end of the potentiometer while the range switch is in a position so as to open the potentiometer under test from the rest of the circuit.

5.4.3 Set the calibrated frequency dial and range switch on the oscillator to 20.0 Hz. Starting with potentiometer A1R11 in a fully clockwise position, rotate this control slowly in the counter clockwise direction until the oscillator output just builds up to full output. Rotating this control too far counter clockwise will cause excessive distortion in the output wave form and/or failure to oscillate properly at 20 KHz.

5.4.4 Vary the frequency of the oscillator from 20 Hz to 20 KHz and check that the oscillator is operating over the full frequency range. If the oscillator does not operate over the full frequency range, set the CALIBRATED DIAL to the upper end of the range that fails to oscillate and adjust the appropriate pair of calibration potentiometers equal amounts but in opposite directions. For example, if the oscillator fails to operate on the 2 KHz to 20 KHz range, set the CALIBRATED DIAL to 20 KHz and adjust A3A1R1 and A3A1R4 equal amounts in opposite directions until the oscillator produces a stable sine wave output.

5.4.5 Vary the frequency of the oscillator from 20 Hz to 20 KHz and check that the oscillator is now working roughly correct and that the frequency of the oscillator is within -0.0 per cent to +5 per cent of the CALIBRATED DIAL setting.

5.5 EXACT FREQUENCY CALIBRATION PROCEDURE FOR WIEN BRIDGE OSCILLATOR ON 20 Hz to 200 Hz RANGE

5.5.1 Check that Section 5.4 of this adjustment procedure has been performed before proceeding to this section of the adjustment procedure.

5.5.2 Select the 20 Hz to 200 Hz range and turn the CALIBRATED DIAL fully clockwise. Record the output frequency of the oscillator. Turn the CALIBRATED DIAL fully counter clockwise and record the output frequency. If the ratio of these two frequencies is less than 10 to 1.0, rotate A3A1R2 and A3A1R5 clockwise, adjusting both potentiometers an equal amount in the same direction. If the ratio of these two frequencies is greater than 10 to 1.0, rotate A3A1R2 and A3A1R5 counter clockwise, adjusting both potentiometers an equal amount in the same direction. If the oscillator stops oscillating during this adjustment procedure, vary A3A1R2 or A3A1R5 somewhat by itself until the oscillation builds up again. If the counter is used in the "period" mode of operation, faster and more accurate results may be obtained.

5.5.3 Repeat step 5.5.2 until the frequency ratio is exactly 10 to 1.0 ±0.1 per cent.

5.5.4 Turn the CALIBRATED DIAL fully clockwise and select equal value capacitors for A3C14 and A3C22 so that the output frequency is 20 Hz ±0.05 Hz.

5.5.5 Turn the CALIBRATED DIAL fully counter clockwise and check that the output frequency is 200 Hz ±0.5 Hz.

5.5.6 Repeat 5.5.2 through 5.5.5 until the dial calibration is within 0.25 per cent at 20 Hz and 200 Hz.

5.6 EXACT FREQUENCY CALIBRATION PROCEDURE FOR WIEN BRIDGE OSCILLATOR ON 200 Hz to 2 KHz RANGE

5.6.1 Check that steps 5.5.1 through 5.5.3 have been performed on the 20 Hz to 200 Hz range before proceeding to the calibration of the 200 Hz to 2 KHz range since potentiometers A3A1R2 and A3A1R5 are used to set the frequency ratio on both of these ranges.

5.6.2 Select the 200 Hz to 2 KHz range and turn the CALIBRATED DIAL fully clockwise. Select A3C9 and A3C17 so that the output frequency is 200 Hz ±0.5 Hz.

5.6.3 Rotate the CALIBRATED DIAL fully counter clockwise. The oscillator frequency should be very close to 2 KHz. If necessary, reselect A3C9 and A3C17 so as to get the best compromise performance (within the ±1.0 per cent frequency accuracy specification) on both ends of the 200 Hz to 2 KHz frequency range.

5.7 EXACT FREQUENCY CALIBRATION PROCEDURE FOR WIEN BRIDGE OSCILLATOR ON 2 KHz to 20 KHz RANGE

5.7.1 Check that Section 5.4 of this calibration procedure has been performed before proceeding to this section of the calibration procedure.

5.7.2 Select the 2 KHz to 20 KHz range and turn the CALIBRATED DIAL fully clockwise. Record the output frequency of the oscillator. Turn the CALIBRATED DIAL fully counter clockwise and record the output frequency. If the ratio of these two frequencies is less than 10 to 1.0, rotate A3A1R1 and A3A1R4 clockwise, adjusting both potentiometer an equal amount in the same direction. If the ratio of these two frequencies is greater than 10 to 1.0, rotate A3A1R1 and A3A1R4 counter clockwise, adjusting both potentiometers an equal amount in the same direction. If the oscillator stops oscillating during this adjustment procedure, vary A3A1R1 or A3A1R4 somewhat by itself until the oscillation builds up again.

5.7.3 Repeat step 5.7.2 until the frequency ratio is exactly 10 to 1.0 ±0.1 per cent.

5.7.4 Turn the CALIBRATED DIAL fully clockwise and select equal value capacitors for A3C7 and A3C15 so that the output frequency is 2 KHz ±5 Hz.

5.7.5 Turn the CALIBRATED DIAL fully counter clockwise and check that the output frequency is 20 KHz ±50 Hz.

5.7.6 Repeat step 5.7.4 through 5.7.5 until the dial calibration is within 0.25 per cent at both ends of the CALIBRATED DIAL.

5.8 FREQUENCY RESPONSE ADJUSTMENTS

5.8.1 The dial calibration procedure outlined in Section 5.4 through 5.7 of this instruction manual should be performed before proceeding to this section.

5.8.2 Monitor the amplitude of the sine wave output of the oscillator at the Phase "A" output with the differential voltmeter. Connect the low side of the differential voltmeter to the circuit ground.

5.8.3 Select the 2 KHz to 20 KHz range and set the CALIBRATED DIAL to 20 KHz. Record the output voltage. Vary capacitors A3C7 and A3C15 equal amounts but in opposite directions so that the output voltage at 2 KHz (on the 2 KHz to 20 KHz range) is within 50 millivolts of the output voltage previously measured at 20 KHz. Check that this adjustment has not affected the dial calibration to any significant degree on the 2 KHz to 20 KHz range. Reselect capacitors A3C7 and A3C15 if the frequency tolerance exceeds ±1 per cent.

5.8.4 Select the 200 Hz to 2 KHz range and set the CALIBRATED DIAL to 200 Hz. Select capacitors A3C9 and A3C17 so that the output at 200 Hz is within 50 millivolts of that at 2 KHz in step 5.8.3 of this procedure.

5.8.5 Vary the frequency from 200 Hz to 2 KHz and check that the output varies less than 10 millivolts over the 200 Hz to 2 KHz range. If problems are encountered, vary potentiometers A3A1R2 and A3A1R5 equal amounts but in opposite directions until the frequency response on the 200 Hz to 2 KHz range is flat within 10 millivolts.

5.8.6 Check that the adjustments in steps 5.8.4 and 5.8.5 have not affected the dial calibration on the 200 Hz to 2 KHz range to any significant degree. Reselect A3C9, A3C17, A3A1R2 and A3A1R5 if the frequency tolerance exceeds ±1 per cent.

5.8.7 Select the 20 Hz to 200 Hz range and set the CALIBRATED DIAL to 200 Hz. Check that the output voltage is within 10 millivolts of that measured at 200 Hz on the 200 Hz to 2 KHz range as determined in step 5.8.5 of this procedure. If problems are encountered, vary capacitors A3C14 and A3C22 equal amounts but in opposite directions until the output at 200 Hz on the 20 Hz to 200 Hz range is within 10 millivolts of the output at 200 Hz on the 200 Hz to 2 KHz range.

5.8.8 Vary the frequency from 20 Hz to 200 Hz and check that the output varies less than 15 millivolts. No adjustment is provided. Repeat steps 5.8.5 through 5.8.7 in such a manner as to obtain the best compromise frequency response on the two lowest frequency ranges, if the output variation exceeds 15 millivolts on the 20 Hz to 20 KHz range.

5.8.9 Vary the frequency from 20 Hz to 20 KHz and check that the phase "A" output varies less than ±100 millivolts from its value at 400 Hz. Repeat steps 5.8.1 through 5.8.8 if the output voltage variation exceeds this limit.

5.9 ABSOLUTE AC OUTPUT VOLTAGE and HARMONIC DISTORTION

5.9.1 The frequency response adjustment procedure given in Section 5.8 should be performed before proceeding to this section.

5.9.2 Monitor the phase "A" output of the oscillator with the differential voltmeter and a distortion analyzer.

5.9.3 Select the 200 Hz to 2 KHz range and set the oscillator frequency to 400 Hz. Select resistor A1R1 so that the AC output voltage is 5.0 volts rms ±25 millivolts.

5.9.4 Vary the output frequency from 20 Hz to 20 KHz and check that the output voltage remains within a ±2.0 per cent band (±100 millivolts) of its value at 400 Hz.

5.9.5 Adjust potentiometer A1R11 for approximately 0.08 per cent (but less than 0.1 per cent) harmonic distortion at 45 Hz. If this control is set for excessively low harmonic distortion then the oscillator may not start properly under all conditions.

5.10 PHASE ADJUSTMENTS FOR MODEL 800T-20/20K-1-2ϕ TWO PHASE OSCILLATOR

5.10.1 Connect the Model 800T-20/20K-1-2ϕ Oscillator as shown in Figure 5 using either the ±25 volt power supply in the California Instruments Invertron® or a pair of external ±25 volt and -25 volt DC power supplies. Check that the procedure given in Section 5.3 through 5.9 of this instruction manual have been performed before proceeding further.

5.10.2 Rotate the front panel AMPLITUDE control fully clockwise. Connect a differential phase meter from the junction of A1R19 and A1CR7 to the junction of A2R17 and A2R3. The phase shift must be -26.57 degrees ±0.25 degrees from 20 Hz to 20 KHz. If problems are encountered, check that steps 5.5 through 5.8 of this procedure have been followed properly. Parameter unbalance in the basic Wien bridge feedback circuit can cause errors in this phase shift.

5.10.3 Set the frequency of the oscillator to 400 Hz and adjust potentiometer A2R2 so that the amplitude of the AC voltage at the junction of A2R3 and A2R17 is equal to the voltage measured at the junction of A1R19 and A1CR7.

5.10.4 Vary the oscillator frequency from 20 Hz to 20 KHz. The AC voltage at the junction of A2R3 and A2R17 should track the AC voltage at the junction of A1R19 and A1CR7. within 15 millivolts.

5.10.5 Monitor the phase "A" output of the oscillator with the differential voltmeter and record the AC output voltage from 20 Hz to 20 KHz.

5.10.6 Monitor the phase "C" output of the oscillator with the differential voltmeter and record the AC output voltage from 20 Hz to 20 KHz. The amplitude of the phase "A" and phase "C" output voltages should now correspond within 100 millivolts of one another.

5.10.7 Connect the differential phase meter from the phase "A" output to the phase "C" output. Readjust potentiometer A2R2 slightly so that the phase "C" output leads the phase "A" output by 90 degrees ±2 degrees and that the amplitude of the phase "C" output tracks the amplitude of the phase "A" output within 75 millivolts from 20 Hz to 20 KHz. Capacitor A2C9 and/or A2C11 (10 pf or less) have been selected at the factory for the best compromise phase shift and amplitude tracking in the 10 KHz to 20 KHz region.

5.11 PHASE ADJUSTMENTS FOR MODEL 800T-20/20K-1-3φD THREE PHASE, OPEN DELTA OSCILLATOR

5.11.1 Connect the 800T-20/20K-1-3φD oscillator as shown in Figure 5 and repeat step 5.10.1 through 5.10.7 except check that the phase shift is 60 degrees ±2 degrees.

5.12 PHASE ADJUSTMENTS FOR MODEL 800T-20/20K-1-3φ THREE PHASE OSCILLATOR

5.12.1 Connect the 800T-20/20K-1-3φ oscillator as shown in Figure 5 and repeat steps 5.10.1 through 5.10.7 except check that the phase shift is 120 degrees ±2 degrees.

5.12.2 Set the frequency of the oscillator to 400 Hz and adjust A2R19 so that the phase "B" output amplitude is equal to the phase "A" output amplitude.

5.12.3 Monitor the phase "A" and the phase "B" output of the three phase oscillator with the differential voltmeter. Select capacitor A2C10 (20 pf or less) so that the frequency response of the phase "B" output most closely tracks that of the phase "A" output in the region from 10 KHz to 20 KHz. Check that the phase "A" output and the phase "B" output are equal to one another within 100 millivolts rms from 20 Hz to 20 KHz.

5.12.4 Vary the frequency of the oscillator from 20 Hz to 20 KHz and check that the phase shift from phase "A" to phase "B" remains within 120 ±2 degrees.

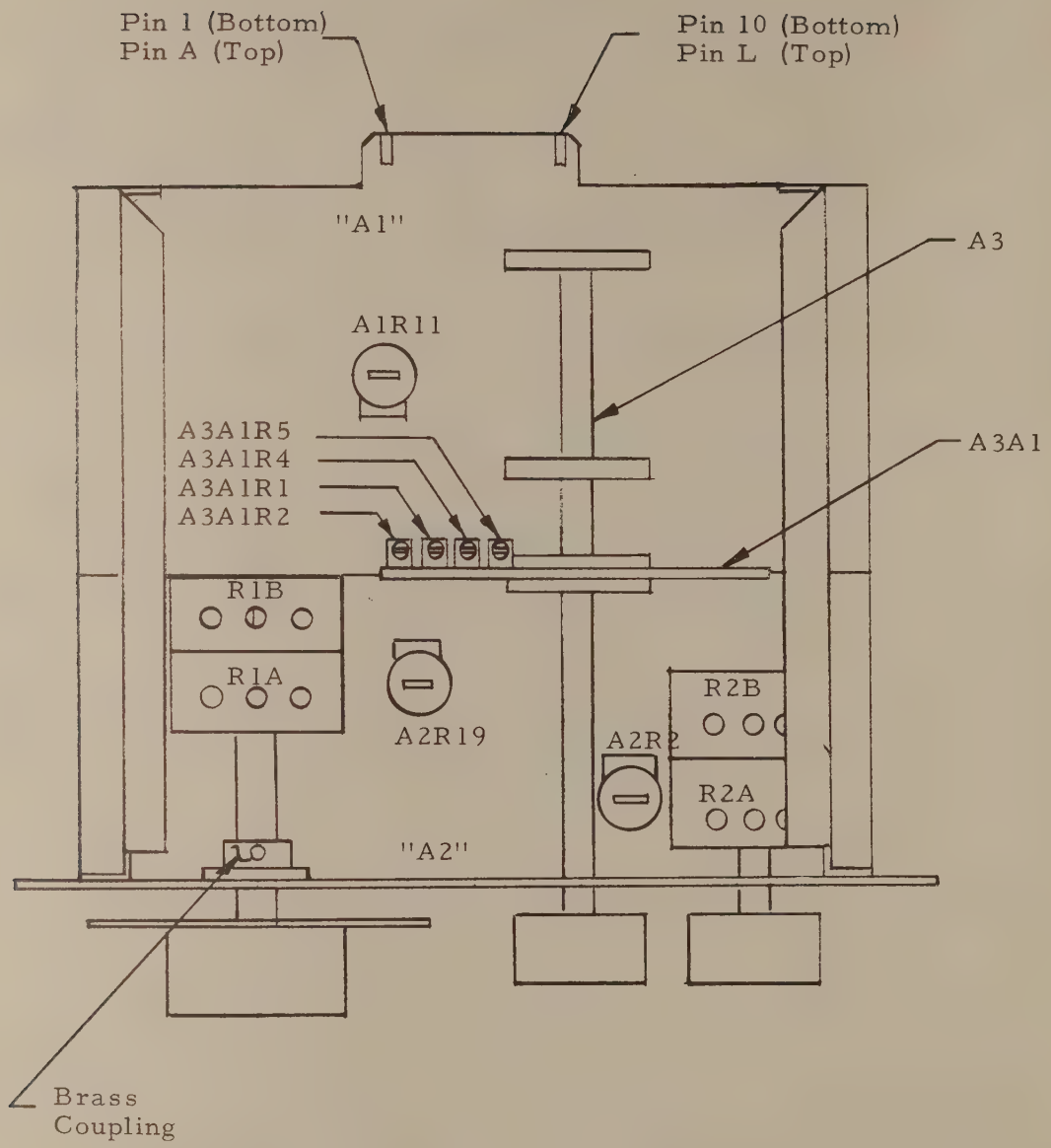


FIGURE 6. Locations of Internal Adjustment Potentiometers.

MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

The California Instruments 800T-20/20K Series Variable Frequency Oscillators are completely solid state and should provide years of trouble-free service. Since the instrument contains no moving parts, periodic maintenance is limited to cleaning in accordance with good commercial shop practices, and a periodic check of frequency accuracy and distortion at six month intervals. If the oscillator is operated in heavy duty applications where severe temperature extremes or mechanical shock are encountered, it is recommended that a more frequent calibration schedule be established.

6.2 TROUBLESHOOTING

6.2.1 Before attempting to repair the oscillator, check that the controls are properly set, that the DC input power is correct and that an excessive load is not connected to the output of the oscillator. Any load impedance less than 5 K ohms per phase should be considered excessive.

6.2.2 Check that the ±15 volt regulator circuits are operating properly and that they have less than 20 millivolts peak-to-peak ripple.

6.2.3 Check that the basic Wien bridge oscillator is operating satisfactorily. Detailed information on this circuit is given in Section 3.1 and Section 5.1 through 5.9 of this instruction manual.

6.2.4 Check that the servo feedback loop is operating satisfactorily. Detailed information on this circuitry is given in Section 3.1 through Section 3.1.6 of this manual. If the problem appears to be in this area, disconnect resistor A1R8 at A1IC3 Pin 6 and apply a +2 volt to +10 volt DC bias to A1R8. This opens the servo feedback loop and allows servicing of this circuitry by conventional signal tracing methods.

6.2.5 If the problem is in the single phase to multi-phase converter, the circuit may be checked by conventional signal tracing methods. Detailed information on the single phase to multi-phase converter circuit is given in Section 3.2 of this instruction manual.

CIRCUIT DIAGRAMS

7.1 GENERAL

This section contains schematics and mechanical diagrams necessary for operation and maintenance of the 800T Series Variable Frequency Oscillators. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

7.2 REFERENCE DESIGNATIONS

Partial reference designators are shown on schematics and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Complete Designation
A1	C30	A1C30
None	T1	T1
A3	CR1	A3CR1
A3A1	R1	A3A1R1

REVISIONS					
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD

WIRING TABLE 1

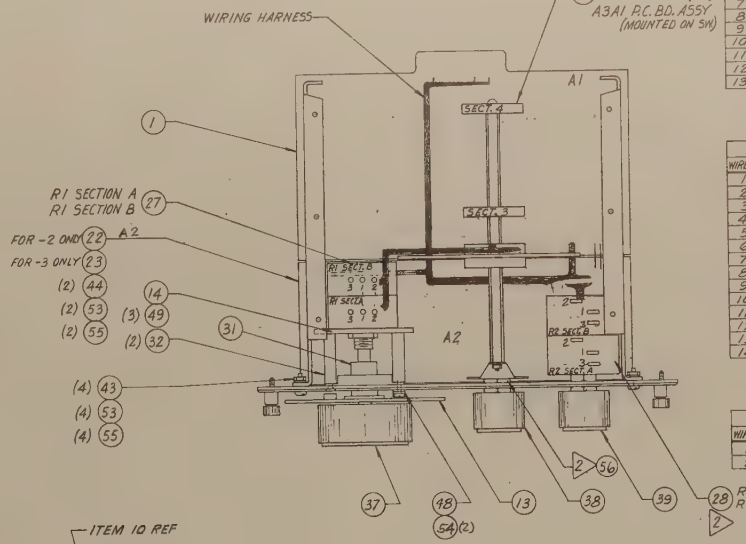
WIRE#	FROM	TO	WIRE	REMARKS
1	A1-21	R1 SEC A-2	24 AWG	BRN
2	A1-11	A3A1-4		RED
3	A1-12	A3A1-1		ORN
4	A1-13	A3A1-3		YEL
5	A1-14	R1 SECT.A-3		GRN
6	A1-15	A3A1-7		BLU
7	A1-16	A3A1-2		VIO
8	A3A1-6	R1 SECT.A-1		GRY
9	A3A1-2	R1 SECT.B-1		WHT
10	A3A1-5	R1 SECT.B-2	24 AWG	WHT/BRN
11	R1 SECT.A-2	R1 SECT.A-3	JUMPER	
12	R1 SECT.B-2	R1 SECT.B-3	JUMPER	
13				

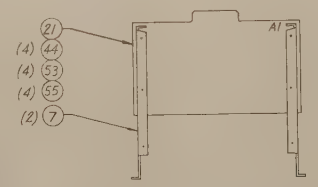
WIRING TABLE 2

WIRE#	FROM	TO	WIRE	REMARKS
1	REMOVE WIRE #1 FROM WIRING TABLE 1*			
2	A1-17	A2-9	JUMPER	
3	A1-18	A2-10	JUMPER	
4	A1-19	A2-11	JUMPER	
5	A2-1	A1-21	24 AWG	BRN
6	A2-2	A1-23		WHT/BLU
7	A2-4	R2 SECT.B-2		WHT/VIO
8	A2-5	R2 SECT.A-2		WHT/GRY
9	A2-6	R2 SECT.A-3		WHT/BLK/BRN
10	A2-7	R2 SECT.B-1		WHT/BLK/RED
11	A2-8	A3A1-8		WHT/BLK/ORN
12	R2 SECT.B-3	R1 SECT.A-2	24 AWG	WHT/BLK/YEL
13	R2 SECT.A-1	R2 SECT.B-1	JUMPER	
14				

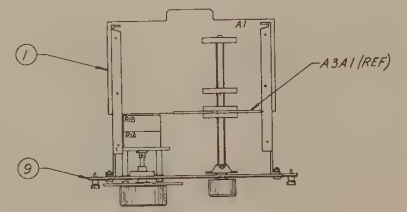
WIRING TABLE 3

WIRE#	FROM	TO	WIRE	REMARKS
1	A2-3	A1-22	24 AWG	WHT/BLK/ORN
2				

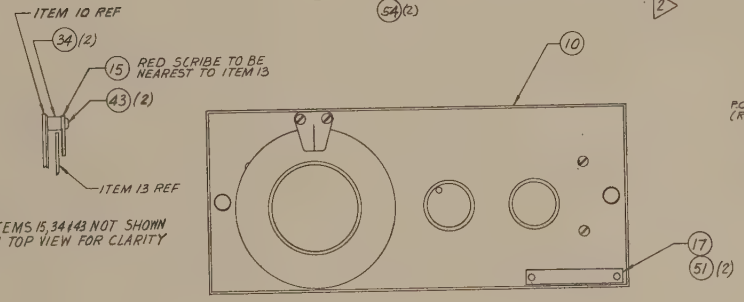


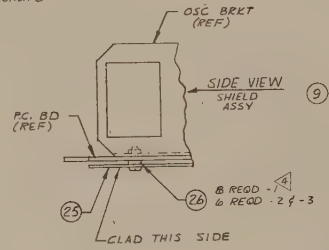


-0 ASSY - COMMON DENOMINATOR
SCALE 1/2



-1 ASSY - SINGLE PHASE (USE WIRING TABLE 1)
SCALE 1/2 (FOR PARTS CALL OUT SEE -2, -3 ASSY)





	4	PL4800-400-3	PARTS LIST	SHEETS 3 & 4				
	3	PL4800-400-2	PARTS LIST	SHEETS 3 & 4				
	2	PL4800-400-1	PARTS LIST	SHEETS 3 & 4				
	1	PL4800-400-0	PARTS LIST	SHEETS 3 & 4				
-3 -2 -1 -0 ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE	
REQD PER ASSY								

DIM IN INCHES TOLERANCES: XXX ± .000, XX ± .03, X ± .30
BREAK ALL SHARP CORNERS & EDGES "MACH SURFACES"
DWG SIZE: D
EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: PRECISION OSCILLATOR
1 Φ, 2 Φ & 3 Φ
MODEL: 800T-20 20KHz 1% ANY PHASE
CONTRACT NO.
CODE IDENT: 16067
DWG NO.: D4800-400
REV: B
SCALE: 1:1
SHEET 2 OF 4

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

RELEASE
CHECKER
DES SUP
DRFTSMN
PURCHASING
PROJ ENGR
CHF ENGR

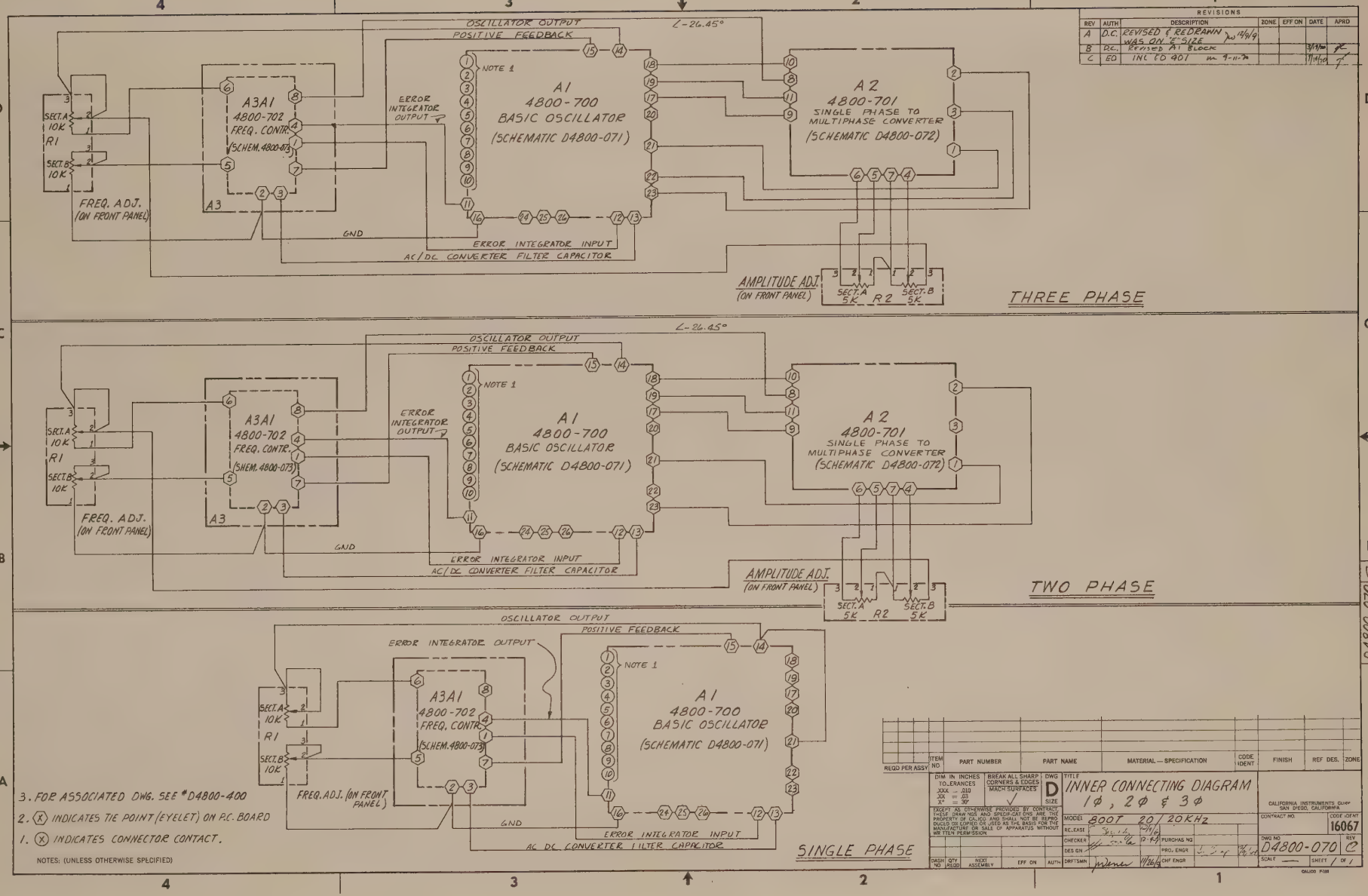
DASH NO. REQD | NEXT ASSEMBLY | EFF ON | AUTH

NOTES: (UNLESS OTHERWISE SPECIFIED)

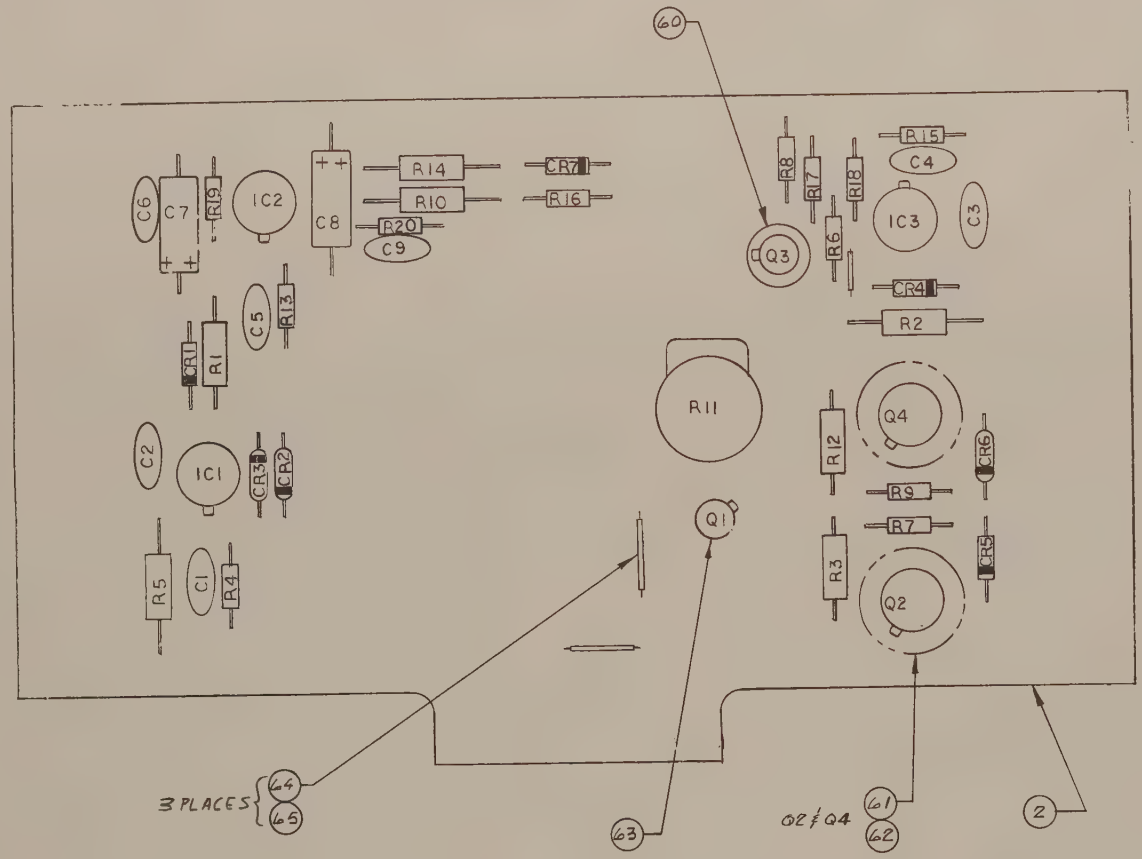
4. INSTALL 2 WASHERS IN FRONT 2 SCREWS WHEN THE P.C. BOARD IS NOT USED.
3. INSPECT GROUND CONTINUITY FROM FRONT PANEL CAPTIVE SCREWS TO GROUND SHIELD.
2. INSTALL WIT ON SW. & POT SIDE/BEHIND F/P) BEFORE INSTALLATION.
1. FOR INNER CONNECTING DIAGRAM SEE DWG. NO. D4800-070

-2 ASSY - TWO PHASE (USE WIRING TABLES 1 & 2)
-3 ASSY - THREE PHASE (USE WIRING TABLES 1, 2 & 3)

D4800-400 B


REVISIONS
REV | AUTH | DESCRIPTION | ZONE | EFF ON | DATE | APRD
A | D.C. | REVISED & REDRAWN WAS ON 5" SIZE | | | 11/4/69 |
B | D.C. | REVISED A1 BLOCK | | | 3/1/70 |
C | ED | INC TO 401 | | | 9-11-70 |
OSCILLATOR OUTPUT
POSITIVE FEEDBACK
∠-26.45°
NOTE 1
A1
4800-700
BASIC OSCILLATOR
(SCHEMATIC D4800-071)
A2
4800-701
SINGLE PHASE TO
MULTIPHASE CONVERTER
(SCHEMATIC D4800-072)
A3A1
4800-702
FREQ. CONTR.
(SCHEM. 4800-073)
A3
SECT. A 10K
R1
SECT. B 10K
FREQ. ADJ.
(ON FRONT PANEL)
ERROR INTEGRATOR OUTPUT
GND
ERROR INTEGRATOR INPUT
AC/DC CONVERTER FILTER CAPACITOR
AMPLITUDE ADJ.
(ON FRONT PANEL)
SECT. A 5K
R2
SECT. B 5K
THREE PHASE
TWO PHASE
SINGLE PHASE
3. FOR ASSOCIATED DWG. SEE #D4800-400
2. (X) INDICATES TIE POINT (EYELET) ON P.C. BOARD
1. (X) INDICATES CONNECTOR CONTACT.
NOTES: (UNLESS OTHERWISE SPECIFIED)
ITEM NO | PART NUMBER | PART NAME | MATERIAL — SPECIFICATION | CODE IDENT | FINISH | REF DES. | ZONE
REQD PER ASSY
TITLE
INNER CONNECTING DIAGRAM
1Φ, 2Φ & 3Φ
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA
MODEL 800T 20/20KHz
CONTRACT NO. 16067
DWG NO D4800-070
REV C
SCALE —
SHEET 1 OF 1
D4800-070 C

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



-1 P.C. BOARD ASSY
VIEW COMPONENT SIDE
TOP CLAD DELETED
A1

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
-1		P/L 4800-700	PARTS LIST	SHEETS 4 & 5				

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √
DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: BASIC OSCILLATOR P.C. BOARD ASSEMBLY A1

MODEL 800T

RELEASE	E. Shipley	4/1/70	PURCHASING
CHECKER		5/31/70	
DESIGN			PROJ ENGR
DRFTSMN	MARTIN	3-25-70	CHF ENGR

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	C4800-400		

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

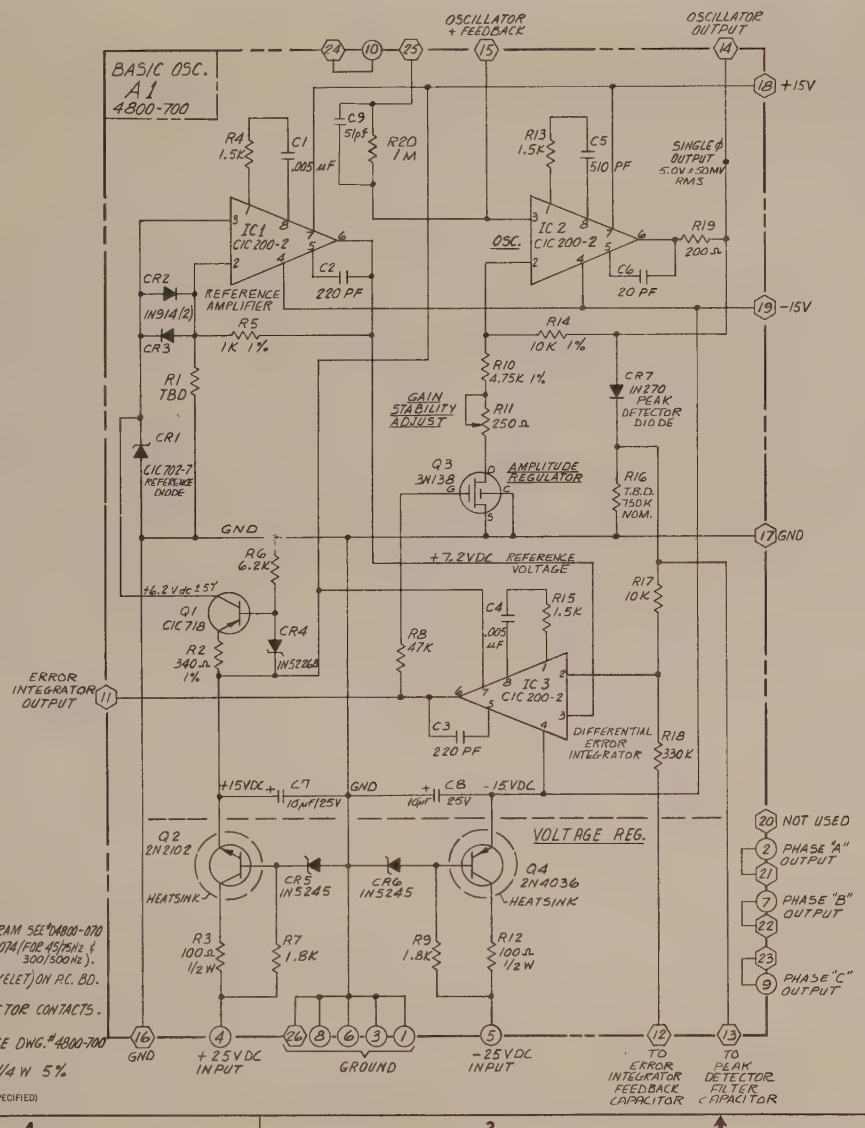
DWG NO. C4800-700 REV D

SCALE 2X SHEET 2 OF 5

1. FOR SCHEMATIC DIAGRAM, SEE DWG NO. D4800-071.

NOTES: (UNLESS OTHERWISE SPECIFIED)

C4800-700



5. FOR INNER CONNECTING DIAGRAM SEE #D4800-070 (FOR 20/120 Hz) AND #D4800-074 (FOR 45/55 Hz & 300/500 Hz).
4. (X) INDICATES TIE POINT (EYELET) ON P.C. BD.
3. (X) INDICATES CONNECTOR CONTACTS.
2. FOR P.C. BD. ASSY SEE DWG. #4800-700
1. RESISTORS ARE 1/4 W 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	E.D.	INC. E.O. 302 & E.O. 362			9/1/70	
B	F.D.	INC E.O. 401			9/1/70	

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES XXX — .010, XX — .03, X° — 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES
DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: SCHEMATIC DIAGRAM BASIC OSC. & VOLTAGE REG.

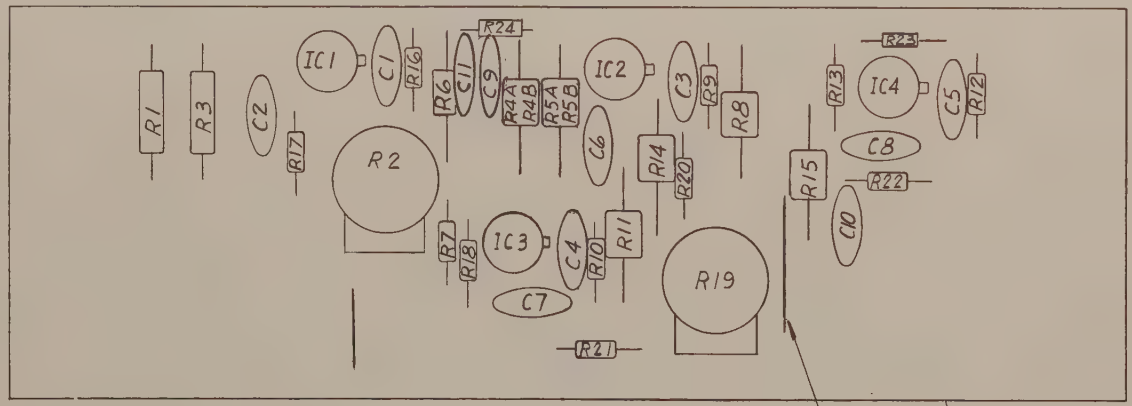
CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

MODEL 800T
CONTRACT NO.
CODE IDENT 16067
RELEASE 9/1/70
CHECKER 12-1-7 PURCHASING
DES GN PROJ ENGR
DRFTSMN CHF ENGR
DWG NO. D4800-071 REV B
SCALE — SHEET 1 OF 1

DASH NO. | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH

D4800-071 B

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



-1 P.C. BOARD ASSY
VIEW COMPONENT SIDE
A2

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
-1		PL4800-701	PARTS LIST	SHEET 4 & 5				

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓
DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE SINGLE PHASE TO MULTIPHASE CONVERTER P.C. BOARD ASSY

MODEL 800T

RELEASE	E. Shultz	10/1/69
CHECKER		10/1/69
DESIGN		PURCHASING
DRFTSMN	Wiemer	9/26/69 PROJ ENGR
		CHF ENGR

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

DWG NO. C4800-701 REV E

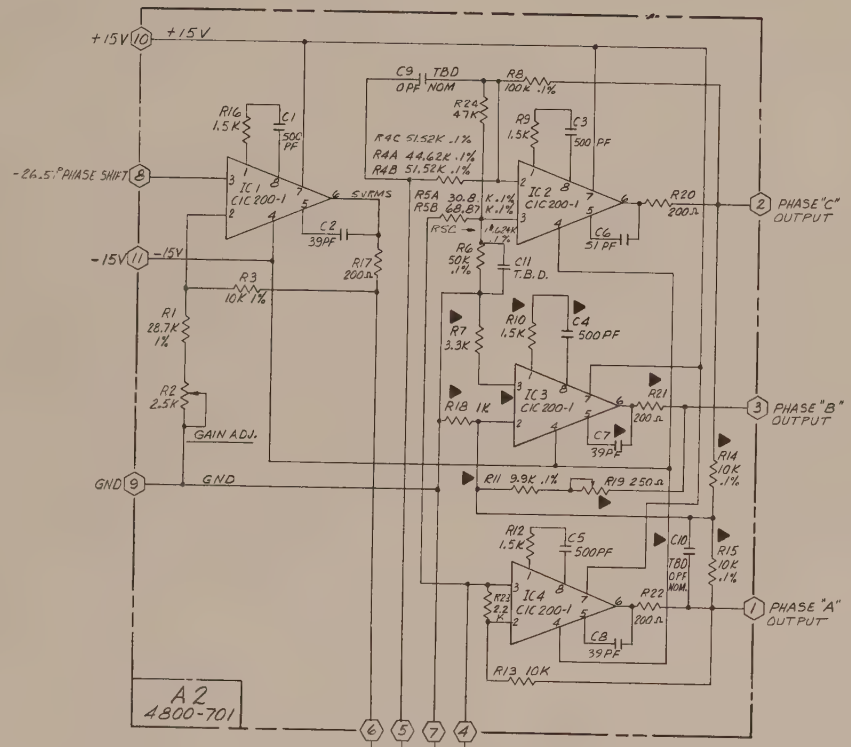
SCALE 2:1 SHEET 2 OF 5

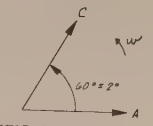
1. FOR SCHEMATIC DIAGRAM SEE DWG. No. D4800-072

NOTES: (UNLESS OTHERWISE SPECIFIED)

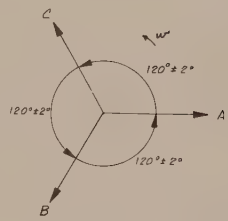
C4800-701 E

REVISIONS					
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE / APRD
A	DC	(RD DWG TR): ...			3/17/70
B	E.O.	INC E.O 362 & 368			7-17-70
C	E.O.	INC E.O. 401			9/...
D	E.O.	INC E.O 422			11/...
E	DC	DELETES REF DES: ...			12/...
F	DC	26.57° MAX 26.45°			4/...

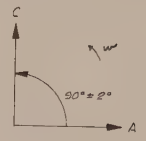




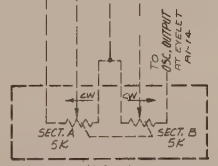
VECTOR DIAGRAM FOR THREE PHASE OPEN DELTA VERSION OF OSCILLATOR



VECTOR DIAGRAM FOR THREE PHASE VERSION OF OSCILLATOR



VECTOR DIAGRAM FOR TWO PHASE VERSION OF OSCILLATOR



AMPLITUDE ADJ. ON FRONT PANEL (SHOWN FOR REF ONLY)

8. FOR INNER CONNECTING DIAGRAM, SEE DWG.# D4800-070 (FOR 20/20KHz AND #D4800-074 (FOR 45/175Hz & 300/500Hz).
7. ⊗ INDICATES TIE POINT (EYELET) ON P.C. BOARD
6. ALL REF DES. ENDING IN "C" ARE FOR 3Ø OPEN DELTA OPERATION.
5. ALL REF. DES. ENDING IN "B" ARE FOR 3Ø OPERATION.
4. ALL REF. DES. ENDING IN "A" ARE FOR 2Ø OPERATION.
3. ▶ NOT USED FOR TWO PHASE OSCILLATOR OR FOR 3Ø OPEN DELTA OSCILLATOR.
2. FOR P.C. BOARD ASSY SEE DWG #4800-701
1. RESISTORS ARE ¼W 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES: XXX = .010, XX = .03, X° = 30'
BREAK ALL SHARP CORNERS & EDGES
MACH. SURFACES √
DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS CORP. AND SHALL NOT BE REPRODUCED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: SCHEMATIC DIAGRAM, SINGLE PHASE TO MULTIPHASE CONVERTER

CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

MODEL 8007 TWO & THREE PHASE

CONTRACT NO. | CODE IDENT 16067

RELEASE | CHECKER | DESIGN | DRFTSMN | PURCHASING | PROJ ENGR | CHF ENGR

DWG NO. D4800-072 REV F

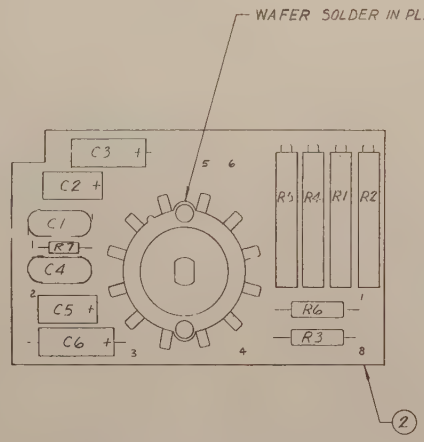
SCALE — SHEET 1 OF 1

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

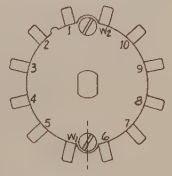
D4800-072 F

A2

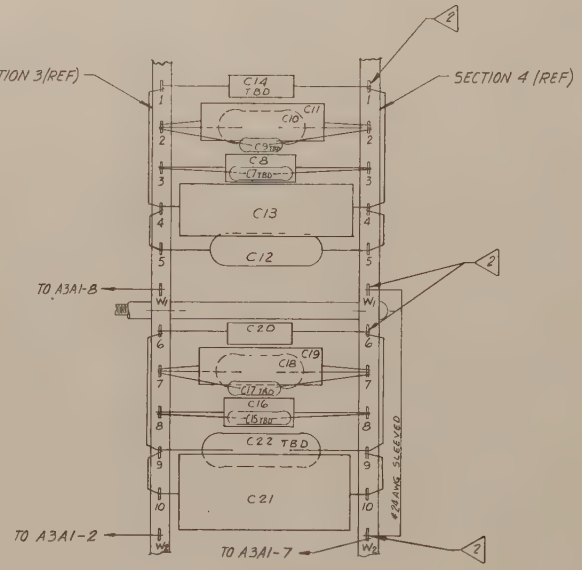
REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	D.C.	SEE SHEET 1				



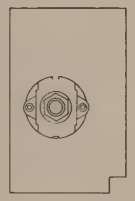
P.C. BOARD ASSY
VIEW COMPONENT SIDE

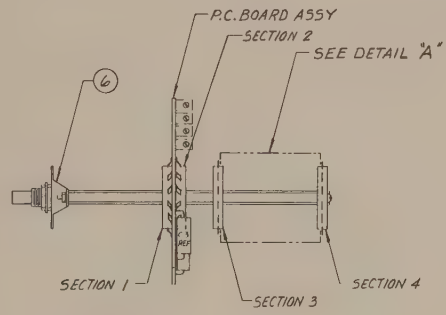


REAR VIEW



SIDE VIEW
SECTIONS 3 & 4





-1 SWITCH ASSY
SCALE 1:1

DETAIL "A"

⚠ 2. TEFLON SLEEVE LEADS OF ALL COMPONENTS TIED TO S1 PINS 1, 6, W1 & W2.
1. FOR SCHEMATIC SEE DWG. No. D4800-073

NOTES. (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
X	-1	PL4800-702	PARTS LIST	SHEET 4 & 5				

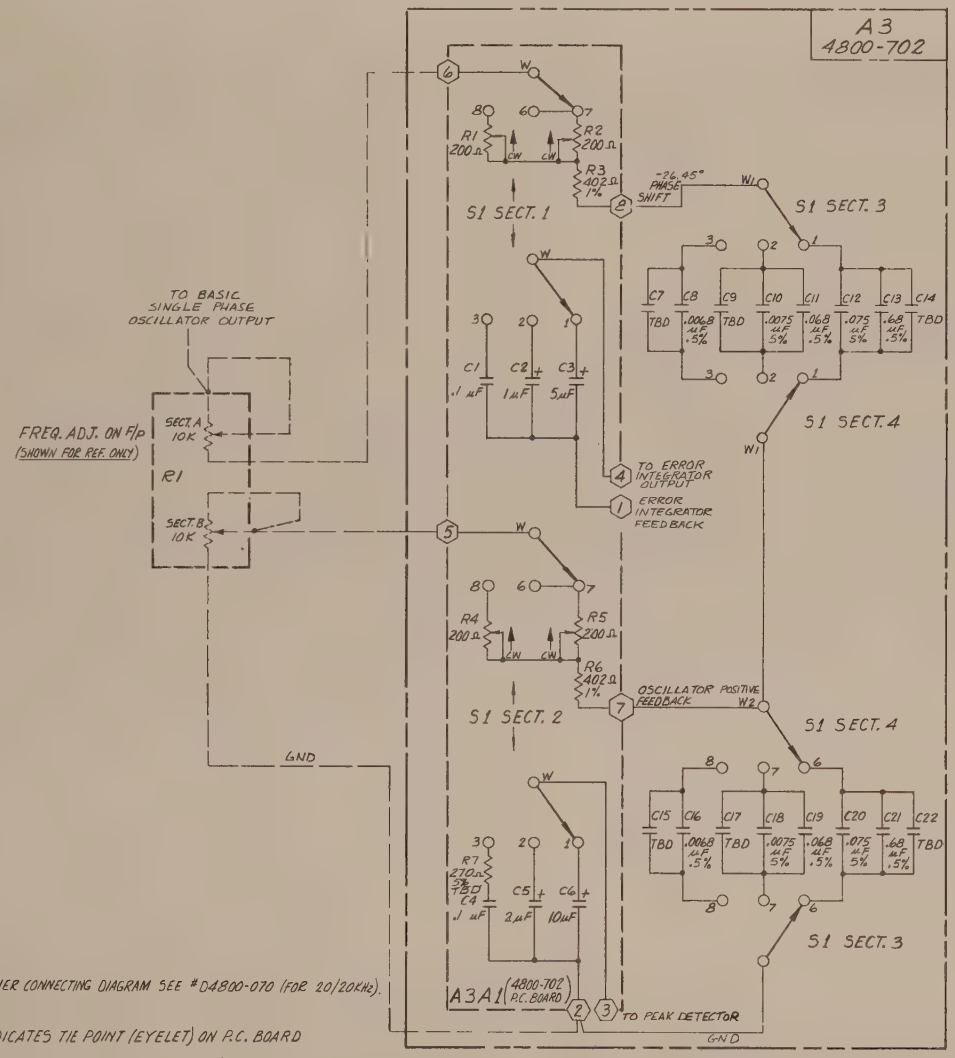
DIM IN INCHES TOLERANCES .XXX = .010, .XX = .03, .X = .30
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓
DWG SIZE D
TITLE: SWITCH ASSEMBLY FREQUENCY CONTROL NETWORK
MODEL 800T
RELEASE Gregg 15 9/14/71
CHECKER 9/17/71
DESIGN
DRFTSMN 9/25/71
PURCHASING
PROJ ENGR
CHF ENGR

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA
CONTRACT NO
CODE IDENT 16067
DWG NO. D4800-702 REV E
SCALE 2:1 SHEET 8 OF 5

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

D4800-702 E



3. FOR INNER CONNECTING DIAGRAM SEE #04800-070 (FOR 20/20KHz).

2. (X) INDICATES TIE POINT (EYELET) ON P.C. BOARD

1. FOR SWITCH ASSY SEE DWG #4800-702.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	EO	INC E.O. 362 thru 2-26-70			3/17/70	JW
B	EO	INC EO 401 & 390			9/14/70	JK

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

D M IN INCHES TOLERANCES XXX ±.010 XX ±.03 X° ±30' | BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓ | DWG SIZE D

TITLE: SCHEMATIC DIAGRAM FREQ. CONTR. NETWORK

CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

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MODEL 800T 20/20KHz | CONTRACT NO. | CODE IDENT 16067

RELEASE | CHECKER | DESIGN | DRFTSMN

PURCHASING | PROJ ENGR | CHF ENGR

DWG NO. D4800-073 | REV B

SCALE — | SHEET 1 OF 1

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

D4800-073 B

REPLACEABLE PARTS

8.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident numbers (see Appendix A for list of manufacturers), and California Instruments' stock numbers are indicated.

8.2 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with CALIFORNIA INSTRUMENTS COMPANY, a division of Aiken Industries, San Diego, California, 92111.

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	4800-400-0	Osc. Common Denominator	16067		1
	4800-400-1	Oscillator--Single Phase	16067		2
	4800-400-2	Oscillator--Two Phase	16067		3
	4800-400-3	Oscillator--Three Phase	16067		4
					5
					6
	4810-201-7	Frame--Plug-in	16067	1-60001	7
					8
	4800-200-1	Front Panel--Single Phase	16067	1-60072	9
	4800-201-1	Front Panel--2ϕ and 3ϕ	16067	1-60073	10
					11
					12
	4800-209-7	Dial Plate	16067	1-60074	13
	4800-203-7	Bracket Freq. Pot	16067	1-60075	14
	4800-204-7	Dial Pointer	16067	1-60076	15
					16
	4810-202-7*	Name Plate Freq. and Phase	16067	1-60000	17
					18
					19
	* SILKSCREEN FREQ., ACCURACY, and PHASE AS DEFINED ON ERA				20
A1	4800-700-1 (ex.	P.C. Assy--Basic Osc.	16067		21
A2	4800-701-1	P.C. Assy--Two Phase	16067		22
A2	4800-701-2	P.C. Assy--Three Phase	16067		23
A3	4800-702-1	Switch Assy--Freq. Contr.	16067		24
	B4810-701-7	Shield	16067	1-60115	25
	NW4-2816	Washer, Nylon	95987	2-10323	26
R1A + B	CIC 503	Pot Dual Gang 10K-10K	16067	5-70108	27
R2A + B	534 5K/5K BUSHING MOUNT	Pot Dual Gang 5K-5K	02111	5-70170	28
					29
					30
	4800-011-1	Ball Drive 5:1 Ratio	16067	2-10000	31
	2374	Spacer 4-40 x 1 Long	83330	2-10025	32
					33
	2340	Spacer #4 x 1/4 Lg.	83330	2-10026	34
					35
					36

MODEL 800T 20/20KHz 1% Anyϕ | CALICO P/N 4800-400 | D | ASSY R.O.

TITLE PRECISION OSCILLATOR -- VAR. 3 BAND | SHT 3 OF 4

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
	PS-175-2-BLK	Knob 1 3/4 Dia.	21604	2-40265	37
	PS-95D-2-BLK	Knob 31/32 Dia.	21604	2-40414	38
	PS-95-2-BLK	Knob 31/32 Dia.	21604	2-40295	39
					40
					41
					42
	4-40 x 7/16 Lg.	Screw, Pan Head			43
	4-40 x 3/8 Lg.	Screw, Flat Head			44
					45
					46
					47
	4-40 x 1/2 Lg.	Screw, Pan Head			48
	4-40 x 3/8 Lg.	Screw, Flat Head			49
					50
	Type U Hardened Metallic	Drive Screw #00x1/8 lg.	45722	2-10024	51
					52
	#4	Washer Int. Star			53
	#4	Washer Small Flat			54
	#4-40	Nut, Hex			55
	9003-NP	Nut, Hex	73734	2-10187	56

MODEL 800T 20/20 KHz 1% any ϕ

CALICO P/N 4800-400 E

ASSY R.O.

TITLE PRECISION OSCILLATOR -- VAR. 3 BAND

SHT 4 OF 4

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1	4800-700-1	P.C. BOARD ASSEMBLY	16067		1
	-7	P.C. BOARD	16067	1-55066	2
	SEE SHEET 3	EYELET			3
					4
					5
A1C1	CK 502	CAPACITOR .005 μf	71590	6-10078	6
A1C2	CM05F221J03	CAPACITOR 220 pf	04062	6-10036	7
A1C3	CM05F221J03	CAPACITOR 220 pf	04062	6-10036	8
A1C4	CK 502	CAPACITOR .005 μf	71590	6-10078	9
A1C5	CM06F511J03	CAPACITOR 510 pf	04062	6-10046	10
A1C6	CM05E200J03	CAPACITOR 20 pf	04062	6-10008	11
A1C7	TE 1204	CAPACITOR 10 μf 25V	56289	6-10338	12
A1C8	TE 1204	CAPACITOR 10 μf 25V	56289	6-10338	13
A1C9	CM05E510J03	CAPACITOR 51 pf	JEDEC	6-10016	14
					15
A1CR1	CIC 702-7	DIODE	16067	3-10189	16
A1CR2	1N 914	DIODE	JEDEC	3-10118	17
A1CR3	1N 914	DIODE	JEDEC	3-10118	18
A1CR4	1N 5226B	DIODE ZENER	04713	3-10129	19
A1CR5	1N 5245	DIODE ZENER	04713	3-10067	20
A1CR6	1N 5245	DIODE ZENER	04713	3-10067	21
A1CR7	1N 270	DIODE	93332	3-10006	22
					23
A1IC1	CIC 200-2	I.C.	16067	3-30006	24
A1IC2	CIC 200-2	I.C.	16067	3-30006	25
A1IC3	CIC 200-2	I.C.	16067	3-30006	26
					27
					28
					29
A1Q1	CIC 718	TRANSISTOR	16067	3-30041	30
A1Q2	2N 2102	TRANSISTOR	95303	3-30075	31
A1Q3	3N 138	MOS FET	95303	3-30136	32
A1Q4	2N 4036	TRANSISTOR	95303	3-30106	33
					34
					35
					36

MODEL 800T | CALICO P/N 4800-700 B | ASSY R.O. A1

TITLE BASIC OSCILLATOR P.C. BOARD ASSEMBLY | SHT 4 OF 5

Aiken Industries	California Instruments Division	CODE IDENT 16067	PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A1R1	TBD	RESISTOR			38
A1R2	RN60D3400F	RESISTOR 340Ω 1% 1/4W	JEDEC	5-60391	39
A1R3	RC20GF101J	RESISTOR 100Ω 1/2W 5%	JEDEC	5-20018	40
A1R4	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	41
A1R5	RN60D1001F	RESISTOR 1K 1% 1/4W	JEDEC	5-60020	42
A1R6	RC07GF622J	RESISTOR 6.2K 1/4W 5%	JEDEC	5-10071	43
A1R7	RC07GF182J	RESISTOR 1.8K 1/4W 5%	JEDEC	5-10058	44
A1R8	RC07GF473J	RESISTOR 47K 1/4W 5%	JEDEC	5-10092	45
A1R9	RC07GF182J	RESISTOR 1.8K 1/4W 5%	JEDEC	5-10058	46
A1R10	RN60D4751F	RESISTOR 4.75K 1%	JEDEC	5-60050	47
A1R11	U-201R251B	VAR. RESISTOR 250Ω	16067	5-70012	48
A1R12	RC20GF101J	RESISTOR 100Ω 1/2W 5%	JEDEC	5-20018	49
A1R13	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	50
A1R14	RN60D1002F	RESISTOR 10K 1% 1/4W	JEDEC	5-60079	51
A1R15	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	52
A1R16	RC07GF754J	RESISTOR 750K 1/4W 5%	JEDEC	5-10120	53
A1R17	RC07GF103J	RESISTOR 10K 1/4W 5%	JEDEC	5-10076	54
A1R18	RC07GF334J	RESISTOR 330K 1/4W 5%	JEDEC	5-10112	55
A1R19	RC07GF201J	RESISTOR 200Ω 1/4W 5%	JEDEC	5-10036	56
A1R20	RC07GF105J	RESISTOR 1M 1/4W 5%	81349	5-10123	57
					58
					59
	05-3308	SOCKET--MOS FET	91662	2-40294	60
	TXBF-032-025B	HEATSINK	98978	2-40120	61
	RCT05075-7A	TRANSIPAD	19080	2-40296	62
	RCT018110-1A	TRANSIPAD	19080	2-40297	63
	#24 AWG	BUSS WIRE			64
	for #24 GA	TEFLON SLEEVING			65

MODEL 800T	CALICO P/N 4800-700	ASSY R.D.
TITLE BASIC OSCILLATOR P.C. BOARD ASSEMBLY	SHT 5 OF 5	A1

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A2	4800-701-0	P. C. BOARD ASSY--Basic	16067		1
	4800-701-1	P. C. BOARD ASSY--Two ϕ	16067		2
	4800-701-2	P. C. BOARD ASSY--Three ϕ	16067		3
	-7	P. C. BOARD	16067	1-55067	4
	SEE SHEET 3	EYELET			5
					6
					7
A2C1	DD 501	CAPACITOR 500 pf	71590	6-10725	8
A2C2	CM05E390J03	CAPACITOR 39 pf	04062	6-10013	9
A2C3	DD501	CAPACITOR 500 pf	71590	6-10725	10
A2C4	DD501	CAPACITOR 500 pf	71590	6-10725	11
A2C5	DD501	CAPACITOR 500 pf	71590	6-10725	12
A2C6	CM05E510J03	CAPACITOR 51 pf	04062	6-10016	13
A2C7	CM05E390J03	CAPACITOR 39 pf	04062	6-10013	14
A2C8	CM05E390J03	CAPACITOR 39 pf	04062	6-10013	15
A2C9	t.b.d.	CAPACITOR			16
A2C10	t.b.d.	CAPACITOR			17
A2C11	CM05	CAPACITOR, T.B.D.	81349		18
					19
					20
A2IC1	CIC 200-1	INTEGRATED CIRCUIT	16067	3-30134	21
A2IC2	CIC 200-1	INTEGRATED CIRCUIT	16067	3-30134	22
A2IC3	CIC 200-1	INTEGRATED CIRCUIT	16067	3-30134	23
A2IC4	CIC 200-1	INTEGRATED CIRCUIT	16067	3-30134	24
					25
					26
					27
A2R1	RN60D2872F	RESISTOR 28.7K 1%	JEDEC	5-60107	28
A2R2	U-201R252	VAR. RESISTOR 2.5K	11237	5-70023	29
A2R3	RN60D1002F	RESISTOR 10K 1%	JEDEC	5-60079	30
A2R4A	S51-9-44.62K-.1%	RESISTOR 44.62K .1%	17745	5-80134	31
A2R4B	S51-9-51.52K-.1%	RESISTOR 51.52K .1%	17745	5-80136	32
A2R5A	S51-9-30.8K-.1%	RESISTOR 30.8K .1%	17745	5-80133	33
A2R5B	S51-9-68.87K-.1%	RESISTOR 68.87K .1%	17745	5-80137	34
A2R6	S51-9-50.0K-.1%	RESISTOR 50K .1%	17745	5-80135	35
A2R7	RC07GF332J	RESISTOR 3.3K 1/4W 5%	JEDEC	5-10064	36

MODEL 800T | CALICO P N 4800-701 | E | ASSY R.O. A2

TITLE SINGLE ϕ TO MULTI ϕ CONVERTER BOARD ASSEMBLY | SHT 4 OF 5

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITE NO
A2R8	S51-9-100.0K-.1%	RESISTOR 100K .1%	17745	5-80138	37
A2R9	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	38
A2R10	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	39
A2R11	S51-9-9.9K-.1%	RESISTOR 9.9K .1%	17745	5-80131	40
A2R12	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	41
A2R13	RC07GF103J	RESISTOR 10K 1/4W 5%	JEDEC	5-10076	42
A2R14	S51-9-10.0K-.1%	RESISTOR 10K .1%	17745	5-80132	43
A2R15	S51-9-10.0K-.1%	RESISTOR 10K .1%	17745	5-80132	44
A2R16	RC07GF152J	RESISTOR 1.5K 1/4W 5%	JEDEC	5-10057	45
A2R17	RC07GF201J	RESISTOR 200Ω 1/4W 5%	JEDEC	5-10036	46
A2R18	RC07GF102J	RESISTOR 1K 1/4W 5%	JEDEC	5-10053	47
A2R19	U-201R251B	VAR. RESISTOR 250Ω	11237	5-70012	48
A2R20	RC07GF201J	RESISTOR 200Ω 1/4W 5%	JEDEC	5-10036	49
A2R21	RC07GF201J	RESISTOR 200Ω 1/4W 5%	JEDEC	5-10036	50
A2R22	RC07GF201J	RESISTOR 200Ω 1/4W 5%	JEDEC	5-10036	51
A2R23	RC07GF222J	RESISTOR 2.2K 1/4W 5%	JEDEC	5-10060	52
A2R24	RC07GF473J	RESISTOR 47K 1/4W 5%	JEDEC	5-10092	53
					54
					55
	#24 AWG	BUSS WIRE			56
					57

MODEL 800T | CALICO P/N 4800-701 | D | ASSY R.

TITLE SINGLE ϕ TO MULTI ϕ CONVERTER BOARD ASSEMBLY | SHT 5 OF 5 | A2

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3	4800-702-1	SWITCH ASSEMBLY	16067		1
	4800-702-7	P. C. BOARD	16067	1-55068	2
	SEE SHEET 3	EYELET			3
					4
					5
A3S1	4800-010	ROTARY SWITCH--SPEC.	16067	2-40415	6
					7
A3A1C1	1DP-2-104	CAPACITOR .1 μf 100V	72136	6-10131	8
A3A1C2	TE-1200	CAPACITOR 1.0 μf 25V	56289	6-10152	9
A3A1C3	TE-1303	CAPACITOR 5 μf 50V	56289	6-10331	10
A3A1C4	1DP-2-104	CAPACITOR .1 μf 100V	72136	6-10131	11
A3A1C5	TE-1201	CAPACITOR 2.0 μf 25V	56289	6-10325	12
A3A1C6	TE-1304	CAPACITOR10 μf 50V	56289	6-10340	13
					14
					15
A3A1R1	ET34X201	VAR. RESISTOR 200Ω	30983	5-70137	16
A3A1R2	ET34X201	VAR. RESISTOR 200Ω	30983	5-70137	17
A3A1R3	RN60C4020F	RESISTOR 402Ω 1%	81349	5-60400	18
					19
A3A1R4	ET34X201	VAR. RESISTOR 200Ω	30983	5-70137	20
A3A1R5	ET34X201	VAR. RESISTOR 200Ω	30983	5-70137	21
A3A1R6	RN60C4020F	RESISTOR 402Ω 1%	81349	5-60400	22
A3A1R7	RC07GF271J	RESISTOR 270Ω 1/4W 5%	81349	5-10039	23
A3C7	t. b. d.	CAPACITOR			24
A3C8	PD5A682 ±. 5%	CAPACITOR .0068 μf .5%	12406	6-10675	25
A3C9	t. b d.	CAPACITOR			26
A3C10	6MPD-2-752J	CAPACITOR .0075μf 5%	72136	6-10676	27
A3C11	PD5A683 ±. 5%	CAPACITOR .068 μf .5%	12406	6-10677	28
A3C12	4MPD-3-753J	CAPACITOR .075 μf 5%	72136	6-10678	29
A3C13	PD5A684 ±. 5%	CAPACITOR .68 μf .5%	12406	6-10679	30
A3C14	t .b .d.	CAPACITOR			31
A3C15	t. b. d.	CAPACITOR			32
A3C16	PD5A682 ±. 5%	CAPACITOR .0068 μf .5%	12406	6-10675	33
A3C17	t. b. d.	CAPACITOR			34
A3C18	6MPD-2-752J	CAPACITOR .0075 μf 5%	72136	6-10676	35
A3C19	PD5A683 ±. 5%	CAPACITOR .068 μf .5%	12406	6-10677	36

MODEL	CALICO P/N		ASSY R.O.
800T	4800-702	D	
TITLE		SHT OF	
P. C. BOARD ASSY FREQ. CONTROL NETWORK		4 5	A3

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CODE IDENT 16067

PARTS LIST

REF. DES.	MFG. NUMBER	DESCRIPTION	CODE IDENT	CALICO STOCK NUMBER	ITEM NO.
A3C20	4MPD-3-753J	CAPACITOR .075 µf 5%	72136	6-10678	37
A3C21	PD5A684 ±.5%	CAPACITOR .68 µf .5%	12406	6-10679	38
A3C22	t.b.d.	CAPACITOR			39
					40
					41
	#24 AWG	BUSS WIRE			42
	for #24 GA	TEFLON SLEEVING			43
	for #20AWG	TEFLON SLEEVING			44

MODEL 800T | CALICO P/N 4800-702 | B | ASSY R.O. A3

TITLE P.C. BOARD ASSY FREQ. CONTROL NETWORK | SHT 5 OF 5

APPENDIX A

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbook H4-1 and its latest supplement. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbook.

0000A	ElectriCord	Westfield, PA
0000B	Tech. Prod. Sales	Sorrento Valley, CA
0000C	Jackson Bros.	Waddon, Surrey, England
0000D	Chicago Std. Transformer Co.	Chicago, IL
0000E	Use Code #08289	
0000F	Colvern	Santa Monica, CA
0000G	Use Code #30983	
0000H	Mial of Italy c/o Q.C. Components	Los Angeles, CA
0000I	Use Code #50522	
0000J	Use Code #34333	
0000K	Elma	Schweiz, Germany
0000L	Use Code #32293	
0000M	Use Code #16950	
0000N	Use Code #15912	
0000R	American Handle	Philadelphia, PA
0000S	OPCDA	Edison, NJ
0000T	Use Code #31743	
0000U	Use Code #32293	
0000V	Falmat	Los Angeles, CA
0000W	Milton Ross Co.	Southampton, PA
0000X	Use Code #52072	
0000Y	Use Code #29990	
00141	Pic Design Corp.	E. Rockaway, NY
00194	Walco Electronics Corporation	Los Angeles, CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood, CA
00656	Aerovox Corporation	New Bedford, MA
00779	AMP, Inc.	Harrisburg, PA
00853	Sangamo Electric Company	Pickens, SC
00866	Goe Eng. Co., Inc.	City of Industry, CA
01121	Allen-Bradley Company	Milwaukee, WI
01179	Ajax Magnethermic Corp.	NE Warren, OH
01255	Litton Industries, Inc.	Beverly Hills, CA
01281	T R W Semiconductors, Inc.	Lawndale, CA
01295	Texas Instruments, Inc.	Dallas, TX
02111	Spectrol Electronics	City of Industry, CA
02114	Ferroxcube Corp.	Saugertiea, NY
02335	Fairchild Controls Corp.	Hicksville, LI, NY
02660	Amphenol Corporation	Broadview, IL
02799	Use Code #72136	
03507	General Electric Company	Syracuse, NY
03508	General Electric Company	Syracuse, NY
03516	General Electric Company	Somersworth, NH
03797	Eldema Corporation	Compton, CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, NJ
03911	Clairex Corporation	New York, NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford, CT
04062	Use Code #72136	
04713	Motorola Semiconductor Prod., Inc.	Phoenix, AZ
04963	3-M	St. Paul, MN
05236	Jonathan Mfg. Co.	Fullerton, CA
05276	Pomona Electronics Co., Inc.	Pomona, CA
05347	Ultronix	Grand Junction, CO
05397	Kemet, Union Carbide Corp.	Cleveland, OH
05820	Wakefield Engineering, Inc.	Wakefield, MA
06046	Dixson Meter	Grand Junction, CO
06184	Conelco Components	San Bernadino, CA
06223	Kooltronic Fan Company	Princeton, NJ
06229	Electrowet, Incorporated	Mt. Vernon, NY
06383	Panduit Corp.	Tinley Park, IL
06514	Stantron, Wyco Metal Products	N. Hollywood, CA
06540	Amathom Elect. Hardward	New Rochelle, NY
06682	Magnetic Shield Div.	Chicago, IL
06776	Robinson, Nugent, Inc.	New Albany, IN
06915	Richco Plastics, Co.	Chicago, IL
07088	Kelvin Electric Company	Van Nuys, CA
07115	Use Code #14674	
07256	Silicon Transistor Corp.	Garden City, NY
07263	Fairchild Camera and Instr. Corp.	Mt. View, CA
07387	Birtcher Corporation	Los Angeles, CA
07556	Unitrack Calabro Plastics	Upper Darby, PA
07633	Epoxy Prod. Co. Div. of Allied Prod. Corp.	New Haven, CT
07713	Sperry Rand Corporation	Norwalk, CT
07716	I R C Incorporated	Burrington, IA
07910	Continental Devices	Hawthorne, CA
08065	Accurate Rubber and Plastics Co.	San Diego, CA
08261	Spectra Strip	Garden Grove, CA
08289	Blinn-Delbert Co., Inc.	Pomona, CA
08594	Eimac Div. of Varian Associates	Salt Lake, UT
08718	Use Code #71468	
08730	Vernaline Products Co.	Franklin Lakes, NJ
09026	Babcock Electronics Corp.	Costa Mesa, CA
09145	Atohm, Technical Industries, Inc.	Burbank, CA
09353	C and K Components, Inc.	Newton, MA
11432	Diamond Metal Sales	Gardena, CA
11815	Cherry Rivet Div., Townsend Co.	Santa Ana, CA
12020	Ovenaire, Incorporated	Charlottesville, VA
12143	Bendix Corporation	Santa Ana, CA
12405	Hysol Corporation	El Monte, CA
12406	Elpac, Incorporated	Fullerton, CA
12463	Omtronics Mfg., Incorporated	Omaha, NE
12673	Wesco Electrical Co.	Greenfield, MA
12697	Clarostat Mfg. Co., Incorporated	Dover, NH
13103	Thermalloy Company	Dallas, TX
13454	Texas Crystals	River Grove, IL
13571	Electronic Research	Overland Park, KS
13919	Burr-Brown Research Corp.	Tucson, AS
14099	Semtech Corporation	Newbury Park, CA
14193	Cal-R Inc.	Santa Monica, CA
14655	Cornell-Dubilier Elect. Corp.	Newark, NJ
14674	Corning Glass Works	Corning, NY
14726	Hollingsworth Co.	Phoenixville, PA
14752	Electro Cube, Incorporated	San Gabriel, CA
14907	Cramer Div. of Conrac	Old Saybrook, CT
15112	Electra Scientific Corporation	Fullerton, CA
15636	Elec-trol	Northridge, CA
15801	Fenwall Electronics	Framingham, MA
15818	Amelco, Teledyne, Incorporated	Mt. View, CA
15909	Use Code #17870	
15912	Ansley	Los Angeles, CA
16067	California Instruments Company	San Diego, CA
16758	Delco Radio Div., General Motors	Kokomo, IN
16795	Bristol Electronics Inc.	Bedford, MA
16902	Simpson Instruments, Inc.	Escondido, CA
16950	Precision Dynamics Corp.	Burbank, CA
17745	Angstrohm Precision, Inc.	Van Nuys, CA
17838	Mektron, California General, Inc.	Chula Vista, CA
17870	Daven Div., Thomas A. Edison	Manchester, NH
18076	Umpco	City of Industry, CA
18121	Wilshire Foam Products, Inc.	Gardena, CA
18178	Vactec Inc.	Maryland Heights, MO
18324	Signatics	Sunnyvale, CA
18612	Vishay Instruments Inc.	Malvern, PA
18677	Scambe Mfg. Co.	Monterey Park, CA
18702	Ducommun Metals and Supply Co.	Los Angeles, CA
18722	R C A	Mountaintop, PA
19080	The Robinson Company	Hawthorne, CA
19781	Potter Company	Sun Valley, CA
20857	South Bay Cable Corp.	Gardena, CA
21270	Behr-Manning	Watervliet, NY
21604	Buckeye Stamping Company	Columbus, OH
22045	Jordan Elect.	Van Nuys, CA
22599	Elastic Stop Nut Corporation	Van Nuys, CA
23039	Deccofelt Products Company	Glendora, CA
23050	Product Components Corp.	Hastings-on-Hudson, NY
23095	Astec Electronics Inc.	Anaheim, CA
23783	British Radio Electric Ltd.	Washington, DC
23936	Pamotor, Incorporated	San Francisco, CA
24011	E C C	Burlington, MA
24655	General Radio	Concord, MA
24796	Parelco Inc.	Paramount, CA
24931	Specialty Connector Co., Inc.	Indianapolis, IN
25403	Amperex (Diodes)	Slaterville, RI
25684	Victoreen Instrument Co., Inc.	Oak Lawn, IL
25706	Daburn Electronics and Cable Corp.	New York, NY
26528	Lamcor, Incorporated	Anaheim, CA
26533	Use Code #98376	
27014	National Semi-Conductor Corp.	Santa Clara, CA
27191	Cutler-Hammer, Inc.	Milwaukee, WI
27264	Molex	Downers Grove, IL
27556	IMP Electronic Products	Santa Fe Springs, CA
27683	Varo, Incorporated	St. Garland, TX
28480	Hewlett-Packard Co.	Palo Alto, CA
*28520	Heyman Mfg. Company (Heyco)	Kenilworth, NJ
30086	I-T-E Circuit Breaker Co.	Philadelphia, PA
30817	Instrument Specialties Co.	Little Falls, NJ
30897	Dorann Co.	Sylmar, CA
30983	Electra/Midland (Mepco/Electra)	San Diego, CA
31743	Elpower	Santa Ana, CA
31951	Tririge Inc.	Pittsburgh, PA
32293	Intersil	Cupertino, CA
34333	Silicon General	Westminister, CA
35929	Constanta	Quebec, Canada
42190	Muter Company	Chicago, IL
44655	Ohmite Manufacturing Company	Skokie, IL
45722	Parker-Kalon	Clifton, NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown, PA
49956	Raytheon Co.	Lexington, MA
50522	Monsanto, Electronic Special Products	Cupertino, CA
51705	ICO/Rally	Palo Alto, CA
52072	Circuit Assembly Corp.	Costa Mesa, CA
53209	W. H. Brady Co.	Milwaukee, WI
56289	Sprague Electric Company	North Adams, MA
57771	Stimson	Bayport, NY
58474	Superior Electric Company	Bristol, CT
59730	Thomas and Betts Company	Elizabeth, NJ
60741	Triplett Electrical Instrument Co.	Bluffton, OH
63743	Ward Leonard Electric Co.	Mt. Vernon, NY
70318	Allmetal Screw Prod. Co.	Garden City, NY
70903	Belden Manufacturing Co.	Chicago, IL
71002	Birnbach Radio Company, Inc.	New York, NY
71218	Bud Radio	Willoughby, OH
71279	Cambridge Thermionic Corp.	Cambridge, MA
71400	Bussman Mfg. Div., McGraw-Edison Co.	St. Louis, MO
71450	CTS Corporation	Elkhart, IN
71468	ITT Cannon Electric, Inc.	Los Angeles, CA
71590	Centralab Div., Globe-Union, Inc.	Milwaukee, WI
71744	Chicago Miniature Lampworks	Chicago, IL
71785	Cinch Manufacturing Company	Chicago, IL
72136	Elmenco (Electro Motive)	Willimantic, CT
72259	Nytronics, Incorporated	Pelham Manor, NY
72619	Dialight Corporation	Brooklyn, NY
72699	General Instruments	Newark, NJ
72982	Erie Technological Products, Inc.	Erie, PA
73138	Beckman Instruments, Inc.	Fullerton, CA
73445	Amperex (Capacitors)	Long Island, NY
73559	Carling Electric, Inc.	West Hartford, CT
73734	Federal Screw Products, Inc.	Chicago, IL
73899	J F D Electronics Company	Brooklyn, NY
73949	Guardian Electric Mfg. Co.	Chicago, IL
73957	Groov-Pin Corporation	Ridgefield, NJ
74193	Heinemann Electric Company	Trenton, NJ
74276	Signalite, Incorporated	Neptune, NJ
74542	Hoyt Electrical Instrument Works	Penacook, NH
74545	Harvey Hubbel, Inc.	Bridgeport, CT
74970	E. F. Johnson Company	Waseca, MN
75382	Kulka Electric Corporation	Mt. Vernon, NY
75915	Littlefuse, Incorporated	Des Plaines, IL
75987	Use Code #95987	
76055	Mallory Controls	Frankfort, IN
76348	Miller Products Company	New York, NY
76385	Minor Rubber Co.	Bloomfield, NJ
76493	J. W. Miller Company	Los Angeles, CA
76854	Oak Manufacturing Company	Crystal Lake, IL
77342	Potter and Brumfield Div., Amer. Machine and Foundry Company	E. Princeton, IN
77638	General Instruments	Brooklyn, NY
77969	Rubber Craft Corp. of California	Torrance, CA
78189	Shakeproof Div., Illoms Tool Works	Chicago, IL
78299	Struthers-Dunn. Incorporated	Pitman, NJ
78488	Stackpole Carbon Company	St. Marys, PA
78526	Stanwyck Winding Company, Inc.	Newburgh, NY
78553	Tinnerman Products, Inc.	Cleveland, OH
78947	Ucinite Company	Newtonville, MA
79130	Johns-Manville Products Corp.	Chicago, IL
79727	Continental-Wirt Electronics Corp.	Warminister, PA
79963	Zierick Mfg. Corporation	New Rochelle, NY
80031	Mepco/Electra	Morristown, NJ
80112	G. C. Electronics Company	Los Angeles, CA
80223	United Transformer Co.	New York, NY
80294	Bourns, Incorporated	Riverside, CA
80368	Sylvania Electric Products, Inc.	New York, NY
80583	Hammarlund Mfg. Co.	Red Bank, NJ
81073	Grayhill, Incorporated	La Grange, IL
81095	Triad Transformer Corp.	Venice, CA
81312	Winchester Electronics	Oakville, CT
81349	Military Spec., Standardization Division Directorate of Logistic Services DSA	
82104	Standard Grigsby	Aurora, IL
82389	Switchcraft, Incorporated	Chicago, IL
82877	Rotron Manufacturing Co., Inc.	Woodstock, NY
82893	Vector Electronics Inc.	Sylmar, CA
83058	Car Fastener Company	Cambridge, MA
83125	Nytronics Inc. Cap. Division	Darlington, SC
83324	Rosan, Incorporated	Newport Beach, CA
83330	Herman H. Smith, Inc.	Brooklyn, NY
83594	Burroughs Corporation	Plainfield, NJ
83701	Electronic Devices, Incorporated	Yonkers, NY
83827	Resistors Inc.	Chicago, IL
84171	Arco Electronics, Inc.	Great Neck, NY
86684	R C A	Harrison, NJ
86928	Seastrom Mfg. Co.	Glendale, CA
87034	Marco-Oak Industries	Anaheim, CA
88026	Use Code #27191	
88245	Useco Div., Litton Industries	Van Nuys, CA
90201	Mallory Capacitor Company	Indianapolis, IN
91459	Alcon Metal Prod. Inc.	Chicago, IL
91506	Augat	Attleboro, MA
91637	Dale Electronics, Inc.	Columbus, NE
91662	Elco Corporation	Willow Grove, PA
91812	Janco Corporation	Burbank, CA
91833	Keystone Electronics Corp.	New York, NY
91929	Micro Switch Div., Honeywell, Inc.	Freeport, IL
92194	Alpha Wire Corporation	Elizabeth, NJ
92219	Waldom Electronics, Inc.	Chicago, IL
93332	Sylvania Electric Products, Inc.	Woburn, MA
94222	Southco, Incorporated	Lester, PA
95146	Alco Electronics Products	Lawrence, MA
95303	B C A	Cincinnati, OH
95416	Use Code #95146	
95987	Weckesser Company, Inc.	Chicago, IL
96682	Genisco, Incorporated	Compton, CA
96733	San Fernando Electric Mfg. Co.	San Fernando, CA
97525	Electronic Engineering Co.	Santa Ana, CA
97918	Linemaster Switch Corp.	Woodstock, CT
97954	U.S. Components, Incorporated	Bronx, NY
98159	Rubber Teck, Incorporated	Gardena, CA
98278	Microdot, Incorporated (Lerco)	S. Pasadena, CA
98291	Sealectro Corp.	Mamaroneck, NY
98376	Zero Mfg. Co. (West)	Burbank, CA
98978	IERC	Burbank, CA
99028	Globe	Gardena, CA
99378	Atlee Corp.	Woburn, MA
99392	STM Corporation	Oakland, CA
99515	Marshall Industries	Monrovia, CA
99517	Vacco Industries	El Monte, CA
99742	Permacel Div., Johnson and Johnson	New Brunswick, NJ
99743	I M C	Maywood, CA
99800	Delevan Electronics Corporation	Aurora, NY
*29990	American Technical Ceramics	Huntington Station, NY

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS COMPANY a division of AIKEN INDUSTRIES INC. warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS COMPANY will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned to the Company freight prepaid, and when examination reveals that the fault has not occurred because of misuse or abnormal conditions of operation. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS COMPANY will submit an estimate for such charges before commencing repair if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS COMPANY or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or shipping instructions will be furnished. If shipment is indicated, forward the instrument, freight prepaid, to the authorized repair station indicated in the instruction. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. CALIFORNIA INSTRUMENTS COMPANY will advise the disposition to be made of the equipment and arrange for repair or replacement. Please include model number and serial number when referring to the instrument.

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